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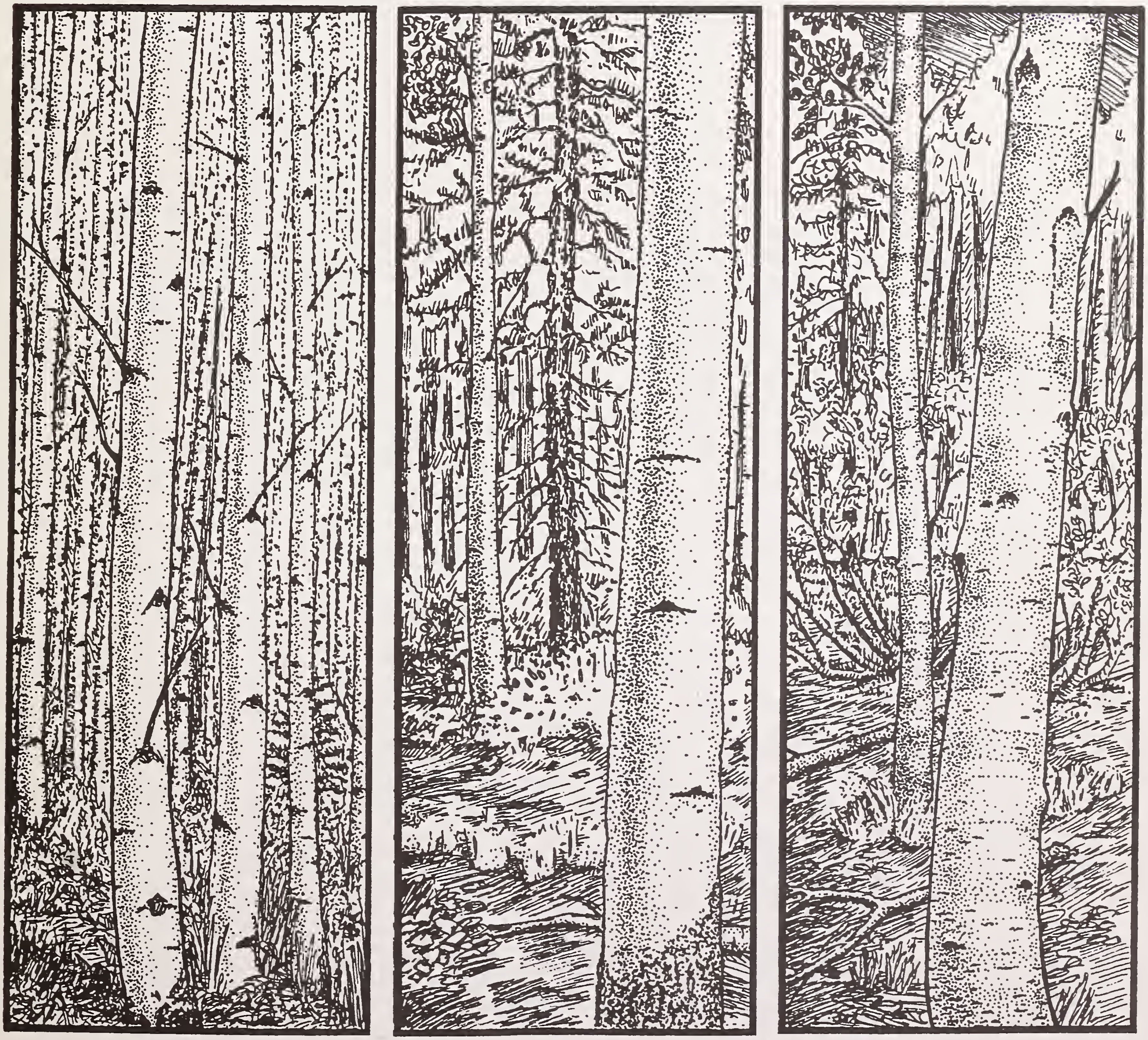
Community Type Classification of Forest Vegetation in Young, Mixed Stands, Interior Alaska

Andrew Youngblood



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Abstract

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Keywords: Vegetation classification, community types, mixed stands, interior Alaska.

Summary

Productive forests of interior Alaska are an extension of the boreal forest zone spanning much of Canada. Upland forests are a mosaic of small stands with various mixtures of conifer and hardwood species including *Betula papyrifera*, *Populus tremuloides*, and *Picea glauca* and lesser amounts of *Populus balsamifera* and *Picea mariana*. Previous descriptions of these upland forests emphasized the relatively infrequent occurrence of pure stands of *Picea glauca*. To further the understanding of forest dynamics and thus opportunities to manipulate interior Alaska boreal forests, this paper describes the structural characteristics of young mixed hardwood and conifer stands, including composition, horizontal and vertical arrangement, and component size.

The objective of field sampling was to collect data across the full range of environmental conditions supporting young mixed stands throughout the uplands of the Fairbanks-Big Delta region. Field work occurred during summers from 1987 through 1990. Criteria for site selection were (1) vegetation homogeneous and representative of other sites within the landscape, (2) tree strata composed of *Picea glauca* and at least one deciduous hardwood species, (3) apparent total age of the dominant stems in the stand between 25 and 100 years, and (4) lack of dominance by *Picea mariana*. Exclusion of sites supporting extensive coverage of *P. mariana* was necessary to restrict the study to the warmest sites with highest productivity.

Canopy coverage of all plant species was estimated ocularly in 375-square-meter circular plots. Elevation, slope, aspect, topographic position, and edaphic characteristics were determined for each plot. Association tables and two-way indicator species analysis (TWINSPAN) were used to develop a classification of the observed forest communities as community types.

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Site description—Each temporary sample plot was circular and slope-corrected to be 375 square meters in size. Plot center was subjectively located within the stand to sample a representative portion of the dominant plant community composition and to avoid obvious ecotones that might occur at stand edges, recently disturbed canopy gaps, or unusual microsites. Photos were taken of each community showing both the undergrowth and overstory composition.

Notes were made on the physical factors of each site, including slope, aspect, and relative slope position and configuration. Elevation was estimated to the nearest contour by using U.S. Geological Survey 15-minute quadrangle maps. Evidence of recent perturbations and potential successional relations were noted, including location of *P. glauca* seed sources, juxtaposition, insect and disease occurrence, and presence of charred snags or charcoal in the forest floor.

Ocular estimates of canopy cover for all vascular species within the plot were made to the nearest percent between 1 and 10 percent and to the nearest 5 percent thereafter. Occasionally these estimates were calibrated by using a series of subplots representing 1, 5, and 25 percent canopy cover. Species present within the plot with less than 1 percent canopy cover were noted as "trace." Other species within the community and not in the plot were noted as "present" but were not included in subsequent data analyses. Three size classes were used for overstory canopy cover by tree species: less than 5 centimeters, 5 to 15 centimeters, and more than 15 centimeters in diameter at 1.37 meters in height above the ground (breast height). This separation was designed to give an indication of the relative importance of each size class by species.

A stand table was constructed, which consisted of a tally of all live and dead stems by species and by 5-centimeter diameter size class at breast height. Trees between 15 centimeters and 1.37 meters in total height were considered saplings and were distinguished from seedlings. Seedlings and saplings were counted on the whole plot.

Cross-sectional disks were cut at ground level from three to five trees of each species. These site trees included the full range of diameter and height classes present in the stand rather than being restricted to any particular canopy position. Additional trees were sampled if a skewed diameter distribution suggested possible age-class differences.

Some sites were randomly selected for detailed stem mapping before plots were established. On these sites, the same 375-square-meter sample plot was used to obtain azimuth and slope distance from plot center to the center of each stem. Mean individual tree canopy diameter was estimated to the nearest decimeter.

Office Methods

All physical site and vegetation data were coded and entered on the computer. Bedrock, surficial geology, and soil series was determined from geologic and soils maps (Brown and Kreig 1983, Furbush and Schoephorster 1977, Rieger and others 1963, Schoephorster 1973). Solar radiation may have a strong influence on species distribution and community composition in these high-latitude forests (Dingman and Koutz 1974); consequently, the index for latitude of equivalent slope (LES) was calculated for each plot based on latitude, azimuth, and slope with the FORTRAN program, SOLAR2.[2]

[2]Fox, J.D. Computer program. Unpublished. On file with: J.D. Fox, Department of Forest Science, University of Alaska Fairbanks, Fairbanks, AK 99775-0100

Taxonomic considerations—Plant specimens that were difficult to identify in the field were identified in the laboratory. Plant taxonomy followed Hultén (1968) for vascular species and Schofield (1969) and Vitt and others (1988) for nonvascular species.

Feathermosses such as *Hylocomium splendens* are a common feature of boreal conifer communities with closed canopies. Other mosses that accounted for significant ground cover included *Pleurozium schreberi* and *Rhytidiadelphus triquetrus*. When other feathermosses were present in only minor amounts (less than 1 percent cover) and *H. splendens* was abundant, all feathermosses were lumped as *H. splendens*.

Community type classification—Preliminary association tables (Mueller-Dombois and Ellenberg 1974) were created by using canopy coverage values for all herbaceous and shrub species in each plot. Canopy coverage of tree species was not considered at this stage of analysis because herbaceous and shrub layers were assumed to be in greater equilibrium with the environment than were tree layers, and because plots were selected by overstory characteristics. Association tables of undergrowth herbaceous and shrub species were rearranged to emphasize differential species that could be used to distinguish groups of stands. Differential species were those having high coverage and fidelity; that is, they represented a significant portion of the total undergrowth canopy cover within a group of stands and had low constancy in other groups of stands.

The same data set was analyzed with numerical classification; the TWINSPAN algorithm (Hill 1979, Hill and others 1975) provided a hierarchical and divisive classification of the sample plot by species matrix. This algorithm is a reciprocal averaging technique for making successive dichotomous divisions of a data set. The procedure involved maximizing species fidelity in two subsets at different layers of classification.

Groupings of plots by TWINSPAN were compared to groupings of plots arranged within association tables, and inconsistences were noted. Plant species having high fidelity and high average cover were noted as indicator species. Individual plots arranged differently by the two methods were included in groups based on the presence and abundance of indicator species. Finally, constancy and average coverage tables for each group were created by using selected representative species and coverage values of all tree species.

A dichotomous key to the types, based on species dominance, was developed. This key was applied to all sample plots, and necessary revisions were made to accommodate variations. A description was prepared for each grouping, including distribution, vegetation, and the physical site characteristics.

The community type was used as the basic unit of vegetation classification in this study. Naming the community type required an ability to recognize communities, defined here as a unit of vegetation somewhat homogeneous in all layers and differing from contiguous vegetation in either quantitative or qualitative characteristics (Daubenmire 1968). In contrast, a community type is an abstract grouping of all communities (or stands) based on floristic and structural similarities in both overstory and undergrowth layers. Naming the community type followed the frequently used convention of a binomial set with the dominant overstory species separated from the dominant or most diagnostic indicator of the undergrowth by a slash (Mueller-Dombois and Ellenberg 1974). When overstory dominance was shared by two tree species, both were included in the community type name. Community types are units of vegetation

representing the existing structure and composition of communities with no implication of successional status. They differ from habitat types, which are units of land supporting or potentially supporting the same climax plant association (Daubenmire 1952, 1989; Pfister and Arno 1980). Once community types are distinguished, successional trends connecting them can be hypothesized and investigated.

The classification was validated by a technician selecting at random from an independent data set comparable plant community data meeting the same criteria of distribution and overstory composition as this study.[3] The key was then applied to this set of data, and undergrowth community composition and environmental setting were compared to the community type descriptions.

Stand physiognomy—Data from the stand tables, including the number of living and dead stems by tree species and diameter class, were summarized by sample plot and community type. Quantitative descriptors of stand density included the number of stems per hectare, number of trees per hectare, basal area per hectare, and the quadratic mean diameter. Number of trees per hectare was calculated as the total number of live stems taller than 1.37 meters. Basal area per hectare was calculated as the sum of the basal area of all individual live stems at breast height. Quadratic mean diameter was calculated as the diameter of a tree of average basal area. Because data came from fixed plots, quadratic mean diameter was the quadratic mean of the sampled tree diameters computed as the square root of the summed products of squared diameter of each class, in centimeters, and the number of stems in the respective diameter classes. Computationally, this is equivalent to the square root of the basal area in square meters, divide by the product of total number of trees per hectare and a constant 7.854×10^{-5} because diameter classes were in centimeters (Weatherhead and others 1985).

Vertical stand physiognomy was described qualitatively by the following categories (Oliver and Larson 1990):

- Emergents (or A-stratum)—stems above the highest continuous canopy.
- Upper continuous canopy (or B-stratum)—the grouping of dominant, codominant, intermediate, and overtopped crowns forming a single distinct layer of tree canopy.
- Understory (or C-stratum, D-stratum and more)—progressively lower strata beneath the upper continuous canopy.
- Forest floor stratum—trees less than 2 meters tall.

Dominant trees are those with at least portions of their crowns at or slightly above the general level of the continuous canopy. These trees receive full sunlight on that portion of the crown extending above the B-stratum. Codominant trees, with the dominant trees, form much of the continuous canopy in any stratum. In the B-stratum, codominant trees receive little direct sunlight from the side of the crown. Intermediate and suppressed or overtopped trees are shorter than the previous two categories and differ in the amount of exposure to the open sky.

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[3]Unpublished data. On file with: Institute of Northern Forestry, 308 Tanana Dr., Fairbanks, AK 99775-5500.

Stem locations from stand mapping data were converted to coordinates and displayed graphically to represent location and circumference of live crown by species. These figures are presented by community type. Normality of the frequency distribution of crown diameters in a stand was tested by the statistic *g'* measuring skewness (Puri and Mullen 1980) for species with at least 25 stems per plot.

Results and Discussion

Community Type Classification

A total of 53 upland mixed conifer and hardwood forest communities were sampled and classified into five community types: **Populus tremuloides/Arctostaphylos uva-ursi**, **Populus tremuloides/Shepherdia canadensis, Betula papyrifera-Populus tremuloides/Viburnum edule, Betula papyrifera-Populus tremuloides/Alnus crispa** and **Picea glauca-Betula papyrifera/Hylocomium splendens**. Throughout the text and tables, community type names are abbreviated by using the standard convention of the first two letters of the genus and species of diagnostic plants; thus **Populus tremuloides/Arctostaphylos uva-ursi = POTR/ARUV**. A key to the community types is presented in appendix C as a tool to assist in using the classification.

Arrangement of community types within the key and within the following discussion progresses along an inferred environmental gradient from the most severe to the least severe, based on species composition and physical characteristics of each sample stand. Manifestation of this inferred environmental gradient is hypothesized as moisture stress.

Briefly, **Populus tremuloides/Arctostaphylos uva-ursi** is a grouping of relatively warm and dry *Populus tremuloides* stands containing *Arctostaphylos uva-ursi* and other low shrubs in the undergrowth. **Populus tremuloides/Shepherdia canadensis** is a grouping of *P. tremuloides*-dominated stands on slightly more mesic sites, with an undergrowth consisting of *Shepherdia canadensis* and other tall shrubs. The **Betula papyrifera-Populus tremuloides/Viburnum edule** and the **Betula papyrifera-Populus tremuloides/Alnus crispa** community types include more mesic stands of either *Betula papyrifera* or *P. tremuloides* or a combination of the two, with different undergrowth species compositions. Finally, **Picea glauca-Betula papyrifera/ Hylocomium splendens** is an aggregation of stands having well-developed moss layers on the forest floor and little shrub cover.

In the following sections, each community type is described by general distribution and physical environment, characteristic vegetation composition and structural features, successional relations of stand development, and relation to other previously described vegetation units. Dot maps (based on fig. 1) indicate known locations of a community type, and corresponding physical data are summarized in appendix D. A major community type covers an extensive area in some drainages. Minor community types may be sporadic throughout the study area but seldom occur as a large unit of vegetation. Constancy and average cover of important plants in each community type are summarized in appendix E. Structural features of the community type include diameter class distributions by species, vertical stratification, spatial arrangement, and stand age and are summarized in appendix F. Vertical and horizontal arrangement of stems for representative stands are presented graphically.

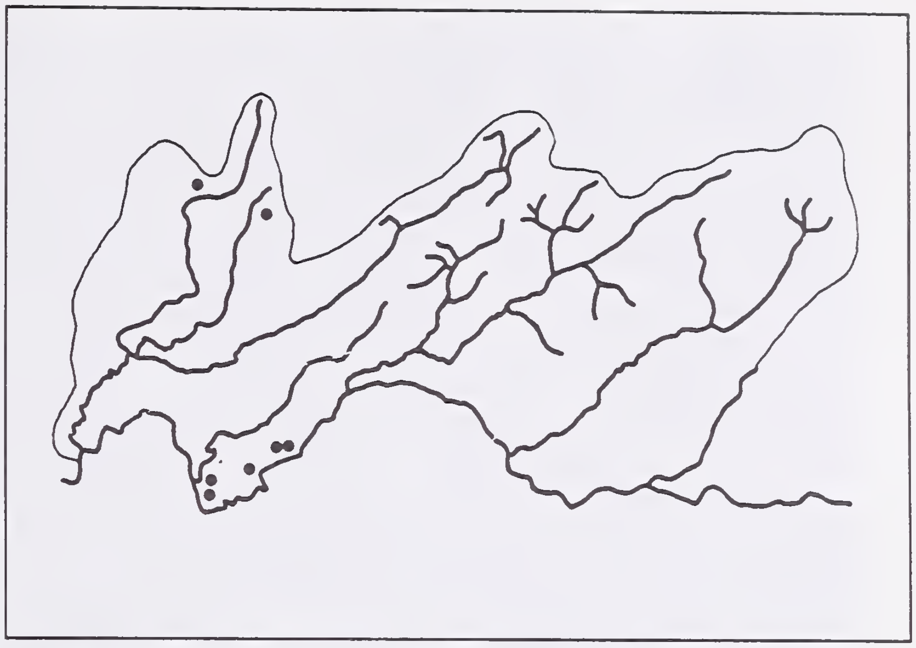


Figure 2—Known locations of the **Populus tremuloides/Arctosaphylos uva-ursi** community type in interior Alaska.

Populus tremuloides/ Arctostaphylos uva-ursi Community Type (POTR/ARUV)

Distribution—POTR/ARUV is a minor community type sampled in the extreme western and northern portions of the study area (fig. 2). It is found between 150 and 410 meters in elevation (mean = 230 meters) on lower slopes and midslopes. It occurs on the warmest and driest sites; exposures range from south to southeast, and slope gradients range from 25 to 55 percent (mean = 39 percent). The LES ranges from 37° to 54° (mean = 45°). Slope configuration is either straight or undulating. Adjacent communities on steeper or more southerly aspects are usually nonforested shrub and graminoid steppe.

The **POTR/ARUV** community type generally occurs on soils classified as either Lithic or Alfic Cryochrepts—light-colored, freely drained soils with limited development that formed under a cryic temperature regime. Lithic soils are shallow, with a bedrock contact within the upper 50 centimeters of the soil surface, and occur near ridgetops and rock outcrops. Alfic soils are deeper soils occurring on middle and lower slopes, and have thin plates in which silicate clays have accumulated. At the family level, these soils are coarse-silty or loamy-skeletal in texture and mixed in mineralogy. Surface organic accumulations within the community type are usually less than 3 centimeters.

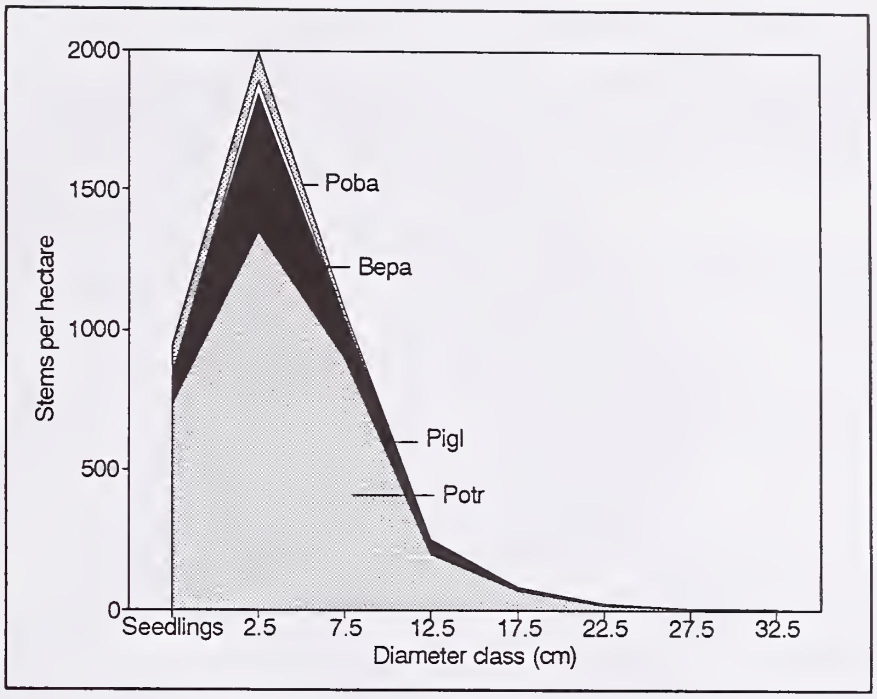
Vegetation composition and structure—*Populus tremuloides* dominates the upper continuous canopy, which generally is between 5 and 15 meters tall (fig. 3). Stands usually are dense, with 1,200 to almost 6,000 trees per hectare (mean ± s.e.= 3,558 ± 550) that are at least 1.37 meters tall. *Populus tremuloides* accounts for 50 to 70 percent total canopy cover and most of the basal area. *Betula papyrifera*, if present, is only a minor component. *Populus balsamifera* usually is present in the upper continuous canopy in small amounts, often as a codominant or overtopped stem, or as saplings in a C-stratum. Isolated individual *Picea glauca* may be present in both the upper continuous canopy (B-stratum) and in the undergrowth stratum. Rarely, *P. glauca* may overtop *Populus tremuloides* and break out as an emergent.

Figure 3—**Populus tremuloides/Arctostaphylos uva-ursi** community type near the Parks Highway on Nenana Ridge west of Fairbanks, Alaska (elevation 152 meters, aspect 180°). *Populus tremuloides* dominates the dense overstory with scattered *Picea glauca* in the overstory and understory. *Arctostaphylos uva-ursi, Viburnum edule,* and *Linnaea borealis* are common shrubs.

The diameter-class distribution of living stems (fig. 4), based on all stems on the site, is skewed slightly to the right. Density of all living stems ranges from 1,627 to over 7,000 stems per hectare (mean ± s.e. = 4,514 ± 705). Basal area per hectare in square meters (mean = 12.55 ± 2.06) and quadratic mean diameter in centimeters (mean = 7.11 ± 1.07) both indicate small diameters for all stems at least 1.37 meters tall. Stands within this community type rarely contain stems larger than 15 centimeters in diameter at breast height. Mortality is concentrated in small-diameter *P. tremuloides* with a minor amount of dead *Picea glauca*.

Total age was determined for 24 *P. glauca*, 17 *Populus tremuloides,* and 2 *B. papyrifera*. The chronosequence of sampled stands in **POTR/ARUV** ranges from 44 to 87 total years of age.

A stem map reflects the high density of stems and the development of small tree crowns found throughout the **POTR/ARUV** (fig. 5). Live crowns on stems taller than 1.37 meters tend to be clustered together and overlapping, with large canopy gaps providing openings for undergrowth development. *Populus tremuloides* in stand 12 had crowns ranging from 0.6 to 5.0 meters in diameter. The frequency distribution was skewed to the right ($g' = 0.71$, $p < 0.01$) because of numerous small stems; mean crown diameter was 1.8 meters, median diameter was 1.7 meters, and the mode was 1.2 meters. *Picea glauca* occurred close to (or under) the crown of *Populus tremuloides* and also occurred in small gaps.



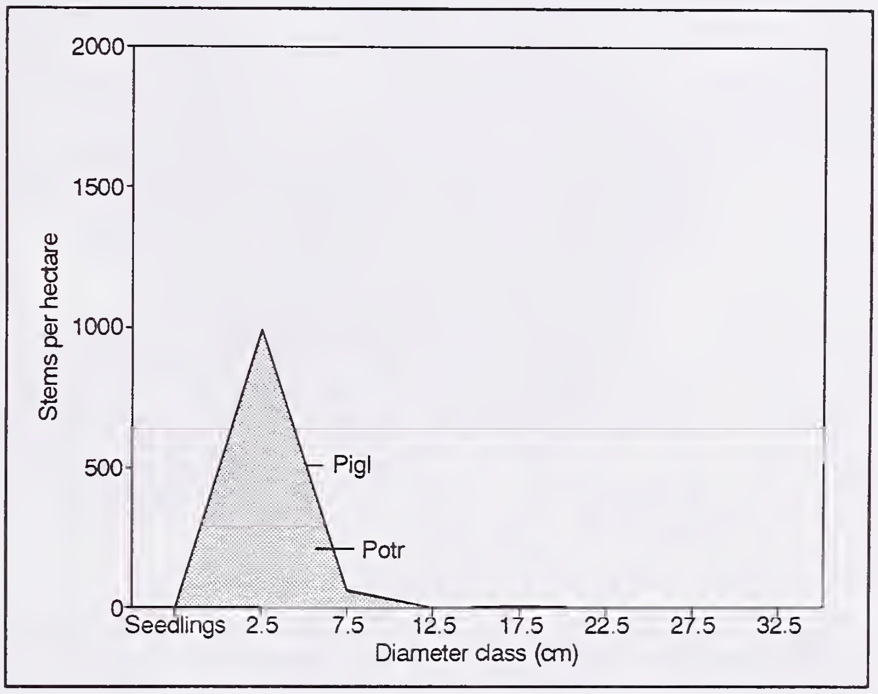


Figure 4—Frequency distribution of living (above) and dead (below) stems by breast-height diameter class and species in the **Populus tremuloides/Arctostaphylos uva-ursi** community type.

The undergrowth in **POTR/ARUV** is dominated by low shrubs, including *Arctostaphylos uva-ursi, Shepherdia canadensis, Linnaea borealis,* and *V. edulė.* Canopy cover of *A. uva-ursi* tends to exceed 50 percent in relatively young stands and to decrease gradually with stand age. Large clumps of *Juniperus communis* sometimes are present. Common herbs include *Cnidium cnidiifolium, Galium boreale, Geocaulon lividum, Zygadenus elegans,* and *Bromus pumpellianus.* The **POTR/ARUV** is the only community type in which the steppe grass *Festuca altaica* was found.

Other studies—POTR/ARUV is similar in name to the **Aspen-white spruce/ Arctostaphylos uva-ursi** vegetation unit listed by Viereck (1975) as representing a stage of succession in which *Picea glauca* replaces the deciduous trees. No detailed

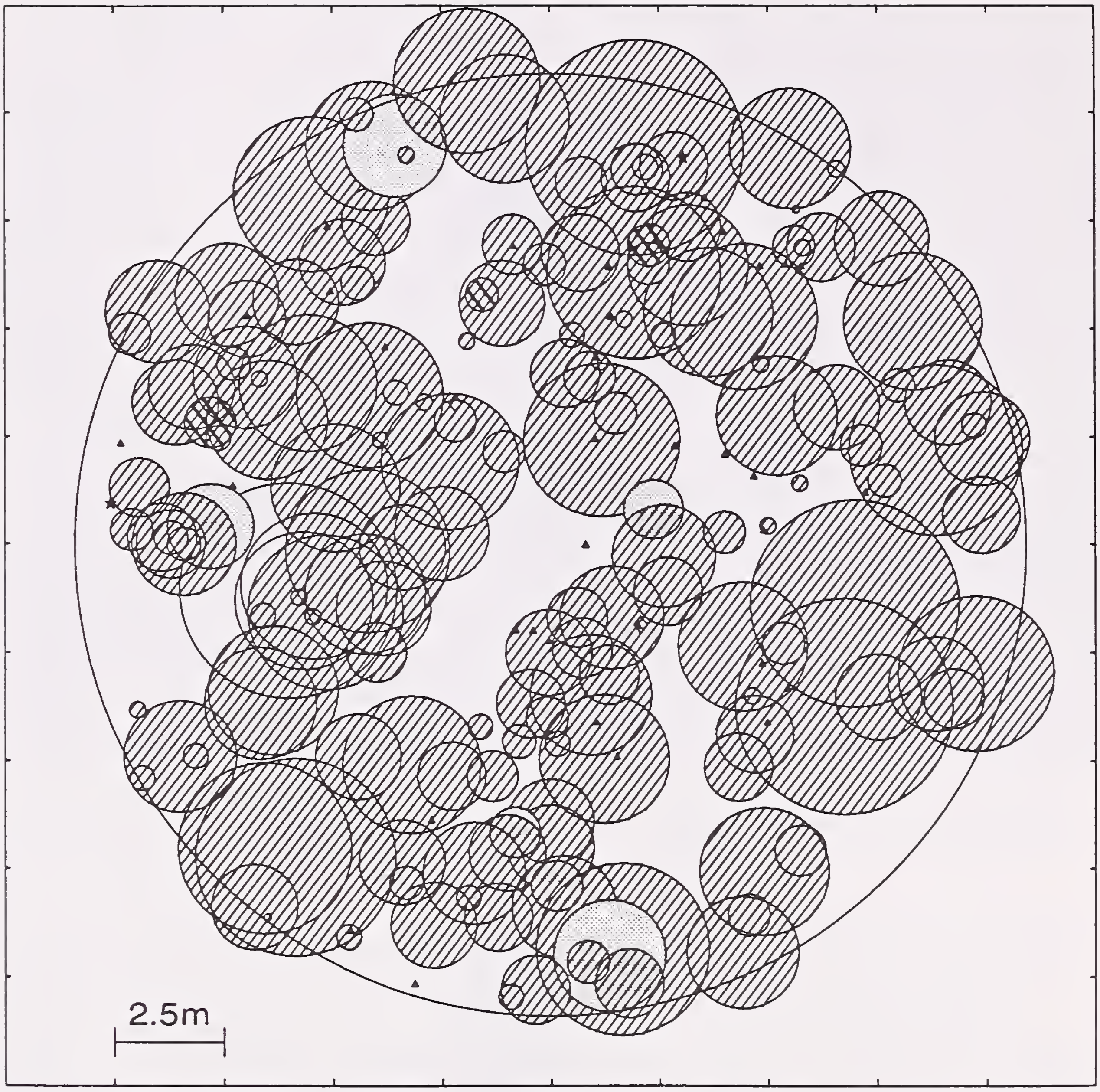


Figure 5—Crown map for stand 12 in the **Populus tremuloides/Arctostaphylos uva-ursi** community type indicating spatial arrangement of stems by species. Fill patterns are: ⊘ = *Populus tremuloides*, ▲ = sucker; ⊘ = *Populus balsamifera*, ★ = seedling; ○ = *Betula papyrifera*; and ○ = *Picea glauca*, ◇ = seedling.

description is provided. Yarie (1983) describes **Populus tremuloides/Salix/ Arctostaphylos uva-ursi** and **Populus tremuloides-Picea glauca/Salix/ Arctostaphylos uva-ursi** communities in the Porcupine River drainage of northeastern Alaska, which differ in site characteristics and species composition.

Viereck and others (1983) describe a single stand dominated by *Populus tremuloides* and *Shepherdia canadensis* that has many affinities to the **POTR/ARUV**; their stand contained only a single tree species, however, and is ecotonal between dense forests and open steppe. Stanek and Orloci (1987) describe a **Populus-Arctostaphylos-Shepherdia** vegetation type on volcanic ash in the Yukon Territory that has some affinity with this **POTR/ARUV** and the **POTR/SHCA** community type. Oswald and Brown (1986) describe a **Populus tremuloides/Arctostaphylos** type on dry sites

with well-drained glaciofluvial and eolian soils in the Lake Laberge ecoregion of the Yukon Territory. Their type is successional to *Picea glauca*-dominated forests, and therefore is distinct rather than disjunct. The **POTR/ARUV**, as described here, represents a new level V type in the Closed Quaking Aspen Forest (I.B.1.e.) of Viereck and others (1992).

Populus tremuloides/ Shepherdia canadensis Community Type (POTR/SHCA)

Distribution—POTR/SHCA is a minor type sampled in the central portion of the study area (fig. 6) on sites between 170 and 300 meters in elevation (mean = 230 meters). It occurs on various aspects from southeast through southwest with gentle to moderately steep slopes (mean = 17 percent). The LES ranges from 47° to 62° (mean = 57°). This type can occur on the full range of slope positions, including upper slopes, lower slopes, and benches. Configurations include all but concave terrain.

The **POTR/SHCA** community type generally occurs on soils classified as Alfic Cryochrepts—light-colored freely drained soils with limited development that formed under a cryic temperature regime. Soil development is manifested in the transportation and accumulation of silicate clays. Some soils supporting this community type may be classified as Aeric Cryaquepts, which indicates saturation of the soil profile during some period of the year and the potential for permafrost deep in the profile. These soils are grayer than those classified as Cryochrepts. At the family level, these soils are coarse-silty in texture and mixed in mineralogy. Surface organic accumulations within the community type usually are less than 3 centimeters deep, similar to those in the **POTR/ARUV** community type.

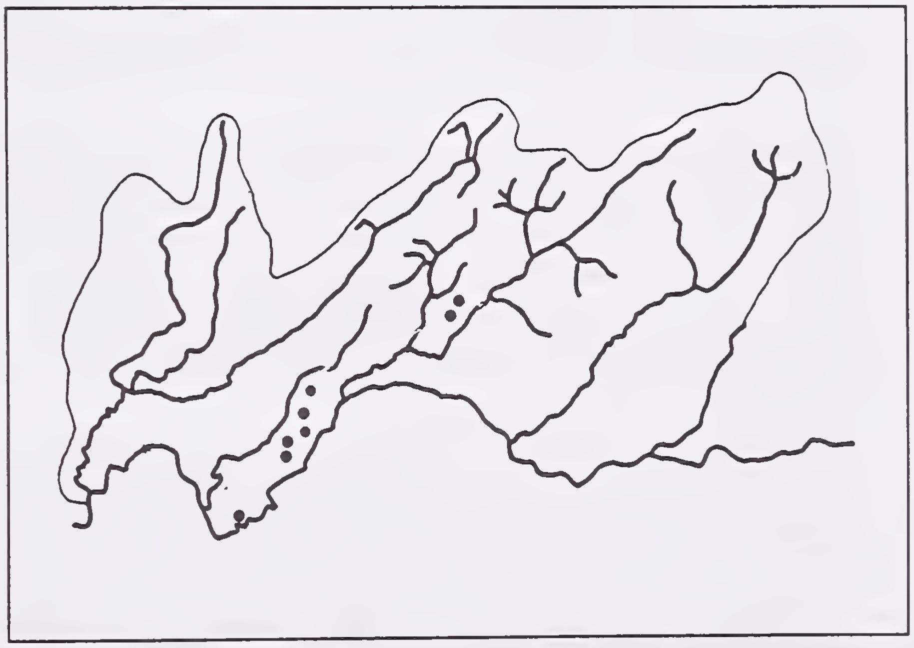


Figure 6—Known locations of the **Populus tremuloides/Shepherdia canadensis** community type in interior Alaska.

Figure 7—**Populus tremuloides/Shepherdia canadensis** community type on Nenana Ridge west of Fairbanks, Alaska (elevation 274 meters, aspect 190°). *Populus tremuloides* dominates the dense overstory with scattered *Picea glauca* in the overstory. *Shepherdia canadensis, Linnaea borealis*, and *Rosa acicularis* are conspicuous in the undergrowth.

Vegetation composition and structure—*Populus tremuloides* dominates the upper continuous canopy in the **POTR/SHCA** community type, the top of which may be from 14 to 22 meters above the ground (fig. 7). Overstories range from 50 to 75 percent canopy cover. Both *Betula papyrifera* and *P. balsamifera* sometimes are present in the B-stratum as scattered codominant or intermediates. *Picea glauca* is most often present as saplings in a lower stratum. Presence of *P. mariana* is sparse and accidental.

The frequency distribution of stems by diameter classes is skewed to the right because of a preponderance of small stem diameters (fig. 8). Density of all living stems ranges from more than 1,500 to almost 6,000 stems per hectare (mean ± s.e. = 3,263 ± 479). Density of living trees at least 1.37 meters tall ranges from more than 1,200 to over 3,500 trees per hectare (mean ± = 2,327 ± 242). Distribution of *Populus tremuloides* is somewhat bell shaped and peaks between 5 and 15 centimeters in diameter. Many stems in the smaller diameter classes have been lost, however, to mortality through competition. *Picea glauca* has an even or uniform frequency distribution in the small diameter classes. Both *Populus balsamifera* and *B. papyrifera* appear as truncated distributions in the middle size classes, thereby suggesting their growth has occurred simultaneously with *P. tremuloides*. Mortality of *P. balsamifera* tends to occur more frequently in the smaller diameter classes.

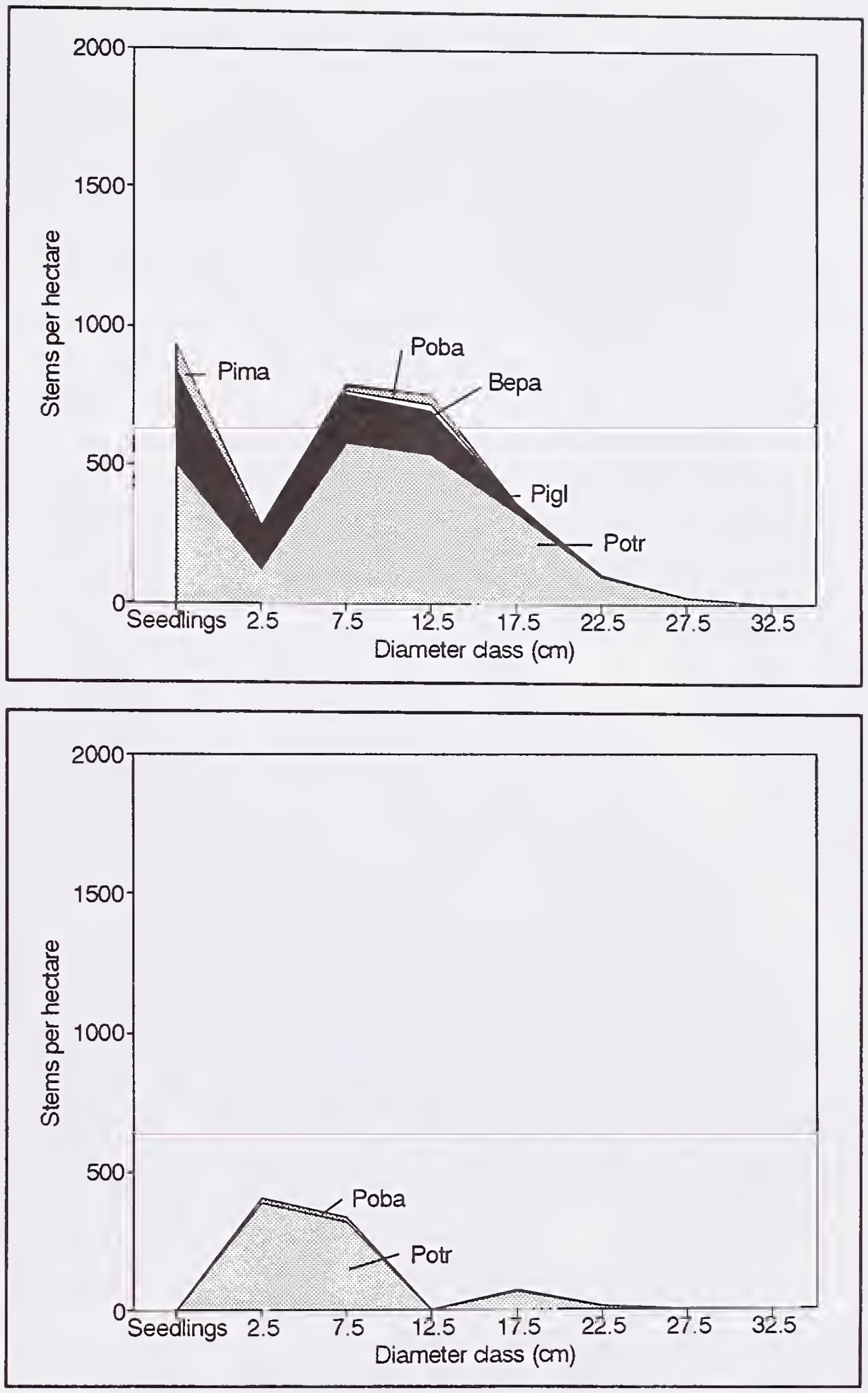


Figure 8—Frequency distribution of living (above) and dead (below) stems by breast-height diameter class and species in the **Populus tremuloides/Shepherdia canadensis** community type.

Populus tremuloides accounts for more than 80 percent of the basal area of living stems taller than 1.37 meters. Basal area per hectare in square meters (mean = 27.22 ± 3.1) and quadratic mean diameter in centimeters (mean = 12.44 ± 0.88), based on all species, are indicative of the larger diameter stems of *P. tremuloides* in this community type compared to the **POTR/ARUV** community type.

Total age was determined for 31 *Picea glauca*, 2 *B. papyrifera*, 22 *Populus tremuloides,* and 3 *P. balsamifera*. The chronosequence of sampled stands in **POTR/SHCA** extends from 63 to 93 total years of age.

Stem maps of two stands within this community type indicate different canopy conditions (figs. 9 and 10). Stand 19 contained over 2,200 trees per hectare, close to the mean for this community type. Individual *P. tremuloides* crowns were tightly clumped and overlapping. Crown size followed a frequency distribution skewed to the left ($g' = -0.93$, $p < 0.01$) and ranging from 0.2 to 6.0 meters in diameter, with mean, median, and mode between 3.7 and 4.0 meters in diameter. *Picea glauca* stems were dispersed throughout the stand. Mean, median, and mode of *P. glauca* crown diameter was 2.0 meters. Total canopy cover of all trees in the upper continuous canopy within stand 19 was estimated at 75 percent. The number of seedlings or suckers was notably small. Stand 8 was composed of fewer trees; both *Populus tremuloides* and *Picea glauca* crowns averaged about 2.0 meters in diameter. The largest *P. glauca* crown was 3.2 meters in diameter. Clustering of both *P. glauca* and *Populus tremuloides* seedlings and suckers was apparent. This stand also contained large canopy gaps devoid of trees. Total canopy cover of all trees in the upper continuous canopy of stand 8 was estimated at 50 percent.

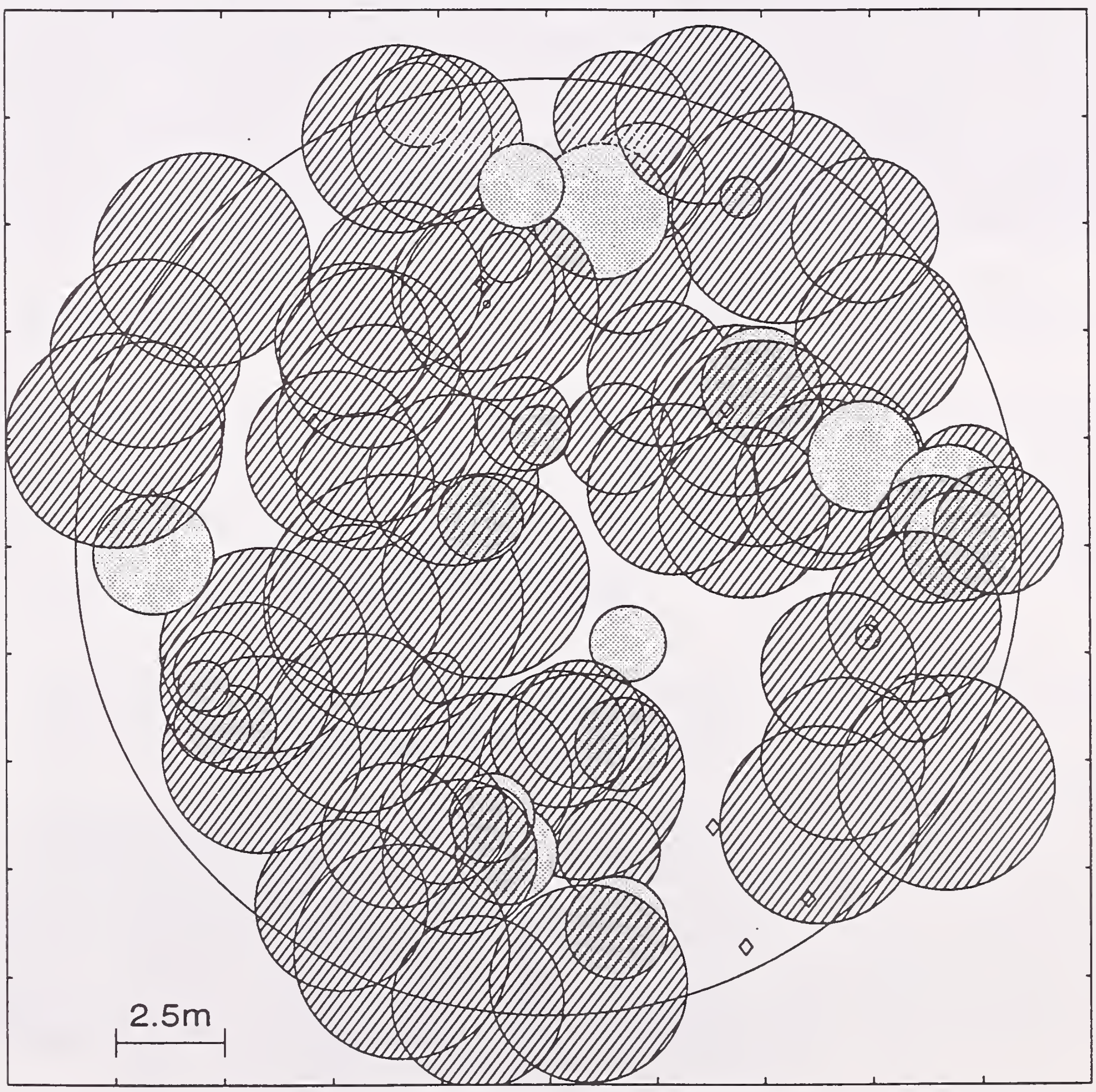


Figure 9—Crown map for stand 19 in the **Populus tremuloides/Shepherdia canadensis** community type indicating spatial arrangement of stems by species. Fill patterns are: ⊘ = *Populus tremuloides*; ○ = *Picea glauca*, and ◇ = seedling.

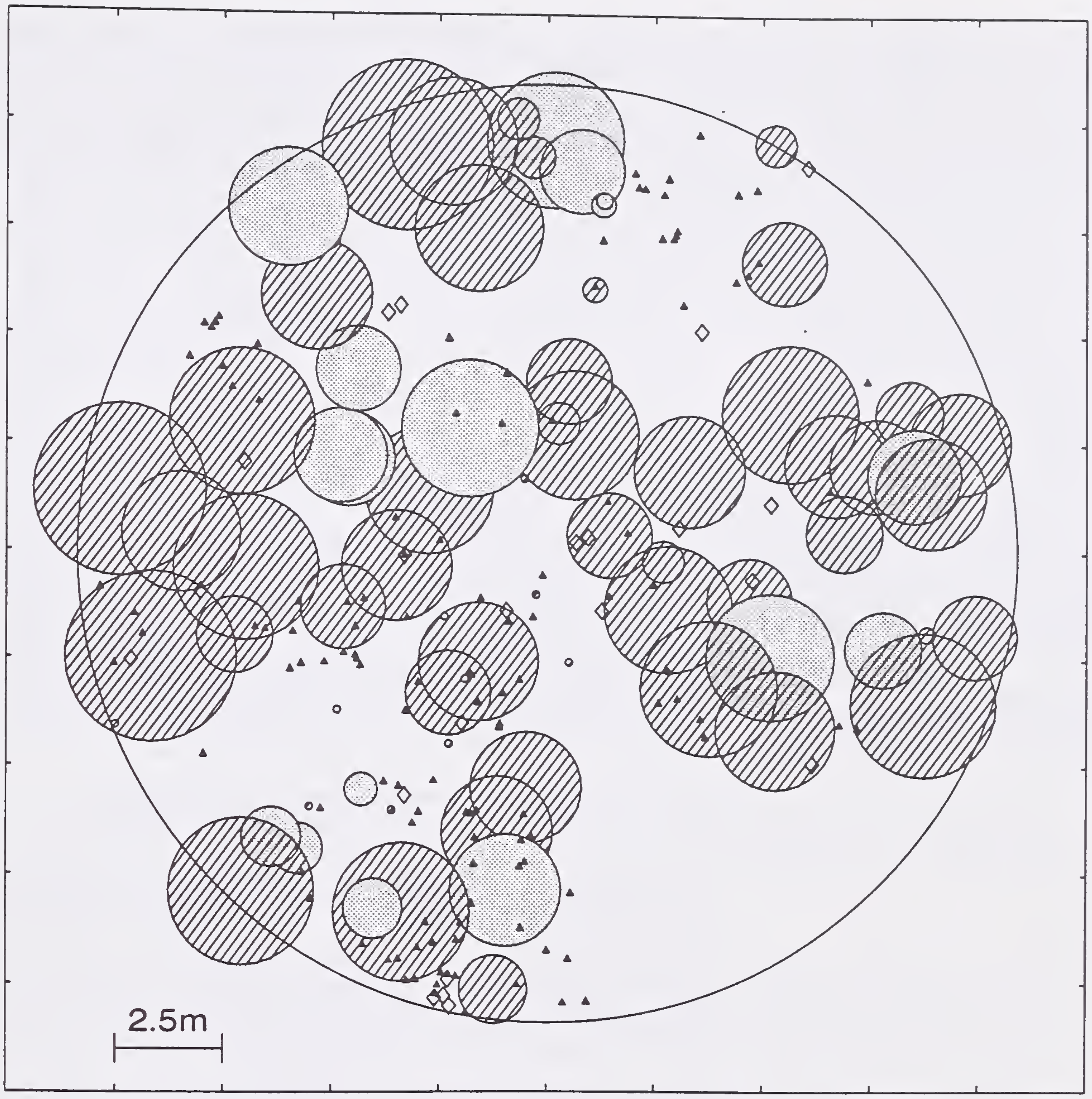


Figure 10—Crown map for stand 8 in the **Populus tremuloides/Shepherdia canadensis** community type, indicating spatial arrangement of stems by species. Fill patterns are: ⊘ = *Populus tremuloides*, ▲ = sucker; ◯ = *Picea glauca*, and ◇ = seedling.

The undergrowth in **POTR/SHCA** is characteristically shrubby, with a tall shrub stratum consisting of *Rosa acicularis, Shepherdia canadensis,* and *Viburnum edule* and a low shrub stratum of *Linnaea borealis.* Cover of forbs is usually sparse and includes *Epilobium angustifolium, Galium boreale*, and *Geocaulon lividum.*

Other studies—No other studies have described **POTR/SHCA**. Stanek and Orloci (1987) describe a **Populus-Arctostaphylos-Shepherdia** vegetation type on volcanic ash in the Yukon Territory that has some affinity with this **POTR/SHCA** and the **POTR/ARUV** community type. Oswald and Brown (1986) describe a **Populus tremuloides/Arctostaphylos** type that occurs on moist to mesic sites with morainal or eolian soils in the Lake Laberge ecoregion of the Yukon Territory. Their type is considered successional to *Picea glauca*-dominated forests, however, and therefore is distinct rather than disjunct. The **POTR/SHCA** community type as described here represents a new level V type in the Closed Quaking Aspen-Spruce Forest (I.C.1.d.) of Viereck and others (1992).

Betula papyrifera-Populus tremuloides/Viburnum edule Community Type (BEPA-POTR/VIED)

Distribution—BEPA-POTR/VIED is a major type sampled throughout the study area (fig. 11) between 150 and 450 meters (mean = 272 meters) in elevation. It typically occurs on middle to upper slopes with gentle to moderately steep gradients (mean = 17 percent) and straight slope configuration or on flat to gentle benches. It occurs on all but northern aspects; the LES ranges from 45° to 65° (mean = 58°).

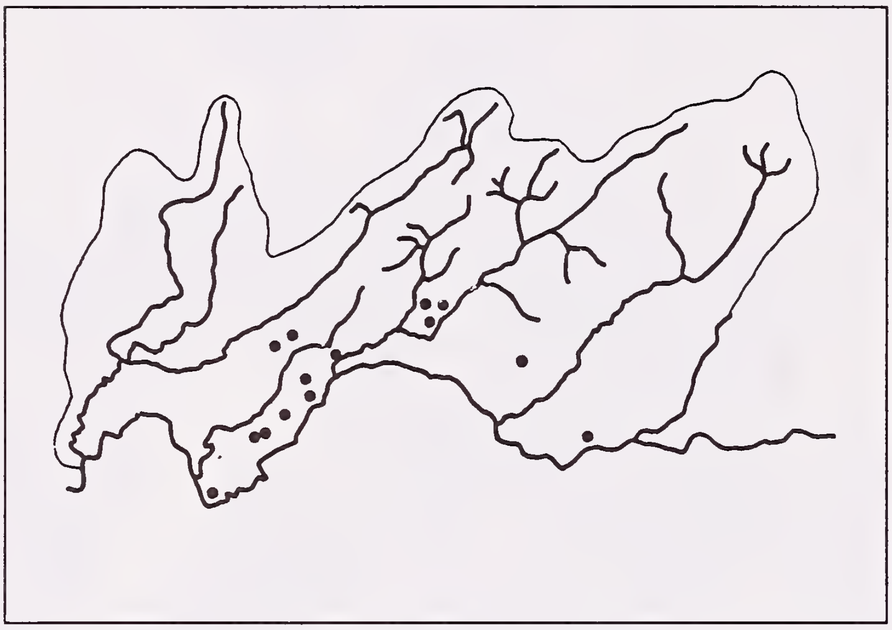


Figure 11—Known locations of the **Betula papyrifera-Populus tremuloides/Viburnum edule** community type in interior Alaska.

Throughout most of the study area, **BEPA-POTR/VIED** occurs on soils classified as Alfic Cryochrepts—light-colored, freely drained soils with limited development that formed under a cryic temperature regime. These soils have thin layers of silicate clays that have accumulated within the profile from weathering of the micaceous loess. At the family level, these soils are classified as loamy-skeletal. Exceptions to this dominant type include colder and wetter soils on toeslopes or within the influence of upland streams. Under these more extreme conditions, soils are classified as either Pergelic or Aeric Cryaquepts, which indicates saturation of the soil profile during some period of the year and the potential for permafrost deep in the profile. Throughout this community type, surface organic accumulations are 3 to 5 centimeters thick.

Vegetation composition and structure—The **BEPA-POTR/VIED** community type is a diverse assemblage of species consisting of several distinct strata. The upper continuous canopy (B-stratum) consists of either *P. tremuloides* or *B. papyrifera* or a combination of the two, is relatively dense, and ranges from 12 to 25 meters tall (fig. 12). *Populus balsamifera* also may occur as a codominant but contributes little canopy cover. *Picea glauca* may occur in a dominant, codominant, or intermediate position within the B-stratum or a lower C-stratum or as an emergent above the B-stratum. Density of all trees at least 1.37 meters tall ranges from 773 to over 6,400 stems per hectare (mean ± s.e. = 2,741 ± 426).

Figure 12—**Betula papyrifera-Populus tremuloides/Viburnum edule** community type in Bonanza Creek Experimental Forest west of Fairbanks, Alaska (elevation 175 meters, aspect 276°). *Betula papyrifera* dominates both the overstory and understory; *Populus tremuloides* and *Picea glauca* occur infrequently in this stand as small-diameter saplings. *Viburnum edule* and *Rosa acicularis* are conspicuous shrubs and *Epilobium angustifolium* is the dominant forb in the undergrowth.

The diameter-class distribution of all stems contains differences by species (fig. 13). Both living and dead *B. papyrifera* have a normal or bell-shaped frequency distribution. The frequency distribution of *Populus tremuloides* also is somewhat normal, although mortality is greatest in the 0- to 5- and 5- to 10-centimeter classes. *Picea glauca* occurs most often as small-diameter stems. Density of all stems is similar to **POTR/SHCA** (mean = 3,436 ± 619). Basal area per hectare in square meters (mean = 26.21 ± 2.14) of trees at least 1.37 meters tall is similar to that in **POTR/SHCA**. *Betula papyrifera* accounts for about 37 percent, *Populus tremuloides* for about 32 percent, and *Picea glauca* for about 15 percent of the basal area. The remaining 16 percent is comprised of *Populus balsamifera* and *Picea mariana*. Quadratic mean diameter in centimeters (mean = 12.4 ± 1.09) is similar to that of **POTR/SHCA**.

Total age was determined for 45 *P. glauca*, 21 *B. papyrifera* and 17 *Populus tremuloides*. The chronosequence of sampled stands in **BEPA-POTR/VIED** ranges from 46 to 136 total years of age.

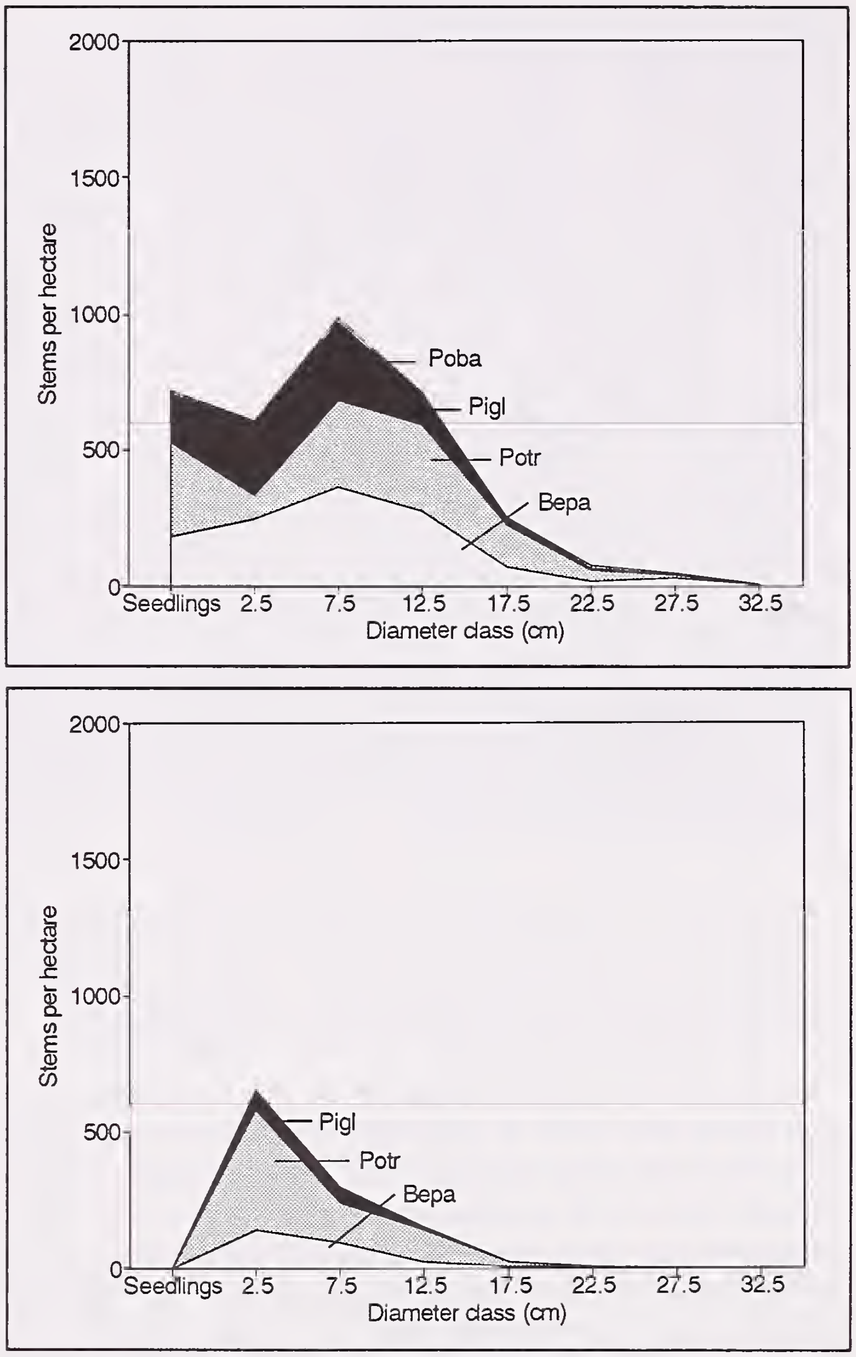


Figure 13—Frequency distribution of living (above) and dead (below) stems by breast height diameter class and species in the **Betula papyrifera-Populus tremuloides/Viburnum edule** community type

Stem maps of two stands portray the variation in crown structure and spatial arrangement of stems in this community type. Stand 5 contained more than 9,000 live stems per hectare, of which 2,320 were live *B. papyrifera* at least 1.37 meters tall (fig. 14). These trees had crowns ranging from 0.2 to 5.0 meters in diameter. Mean crown diameter was 2.6 meters, median was 2.3 meters, and the mode was 2 meters. Crown diameters for *B. papyrifera* followed a normal distribution ($g' = 0.13$, $p < 0.1$). Both *B. papyrifera* and *Picea glauca* occurred throughout as seedlings and saplings. *Picea glauca* tended to be clustered together either directly under a *B. papyrifera* canopy or within a canopy gap, presumably a result of some microsite influence. Overstory canopy cover was estimated at 70 percent.

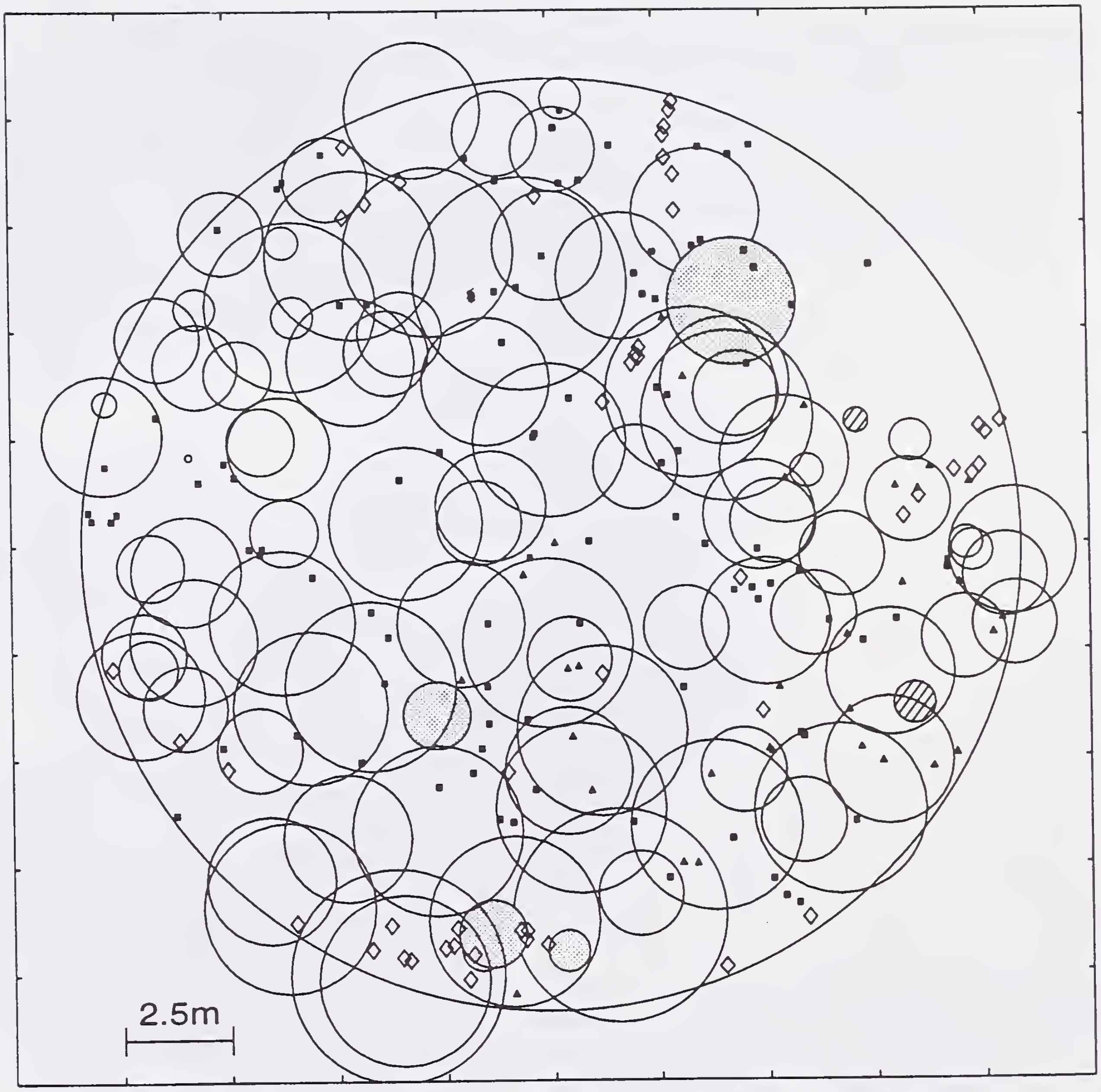


Figure 14—Crown map for stand 5 in the **Betula papyrifera-Populus tremuloides/Viburnum edule** community type, indicating spatial arrangement of stems by species. Fill patterns are: ○ = *Betula papyrifera*, ▪ = seedling; ⊘ = *Populus tremuloides*, ▴ = sucker; ○ = *Picea glauca*, and ◇ = seedling.

Stand 29 was dominated by *Populus tremuloides* and also contained *B. papyrifera*, *P. balsamifera*, and *Picea glauca* (fig. 15). This stand contained 2,240 living stems; almost all were trees taller than 1.37 meters. Crowns were large and overlapping, thereby creating about 80 percent canopy cover. Mean crown diameter of *Populus tremuloides* was 3.3 meters. Crown diameters followed a bell-shaped frequency distribution ($g' = 0.27$, $p < 0.01$). Several *P. tremuloides* and *Picea glauca* crowns exceeded 6 meters in diameter.

A tall shrub stratum in **BEPA-POTR/VIED** includes *Rosa acicularis*, *Viburnum edule*, and sometimes *Alnus crispa*. Low shrubs include *Linnaea borealis* and sometimes *Vaccinium vitis-idaea*. When present, these low shrubs usually account for high ground cover. Cover of herbs is typically sparse. *Epilobium angustifolium, Cornus canadensis*, and *Calamagrostis canadensis* have high constancy but usually low cover. *Equisetum arvense, Hylocomium splendens*, and *Lycopodium* species occasionally may have high ground cover.

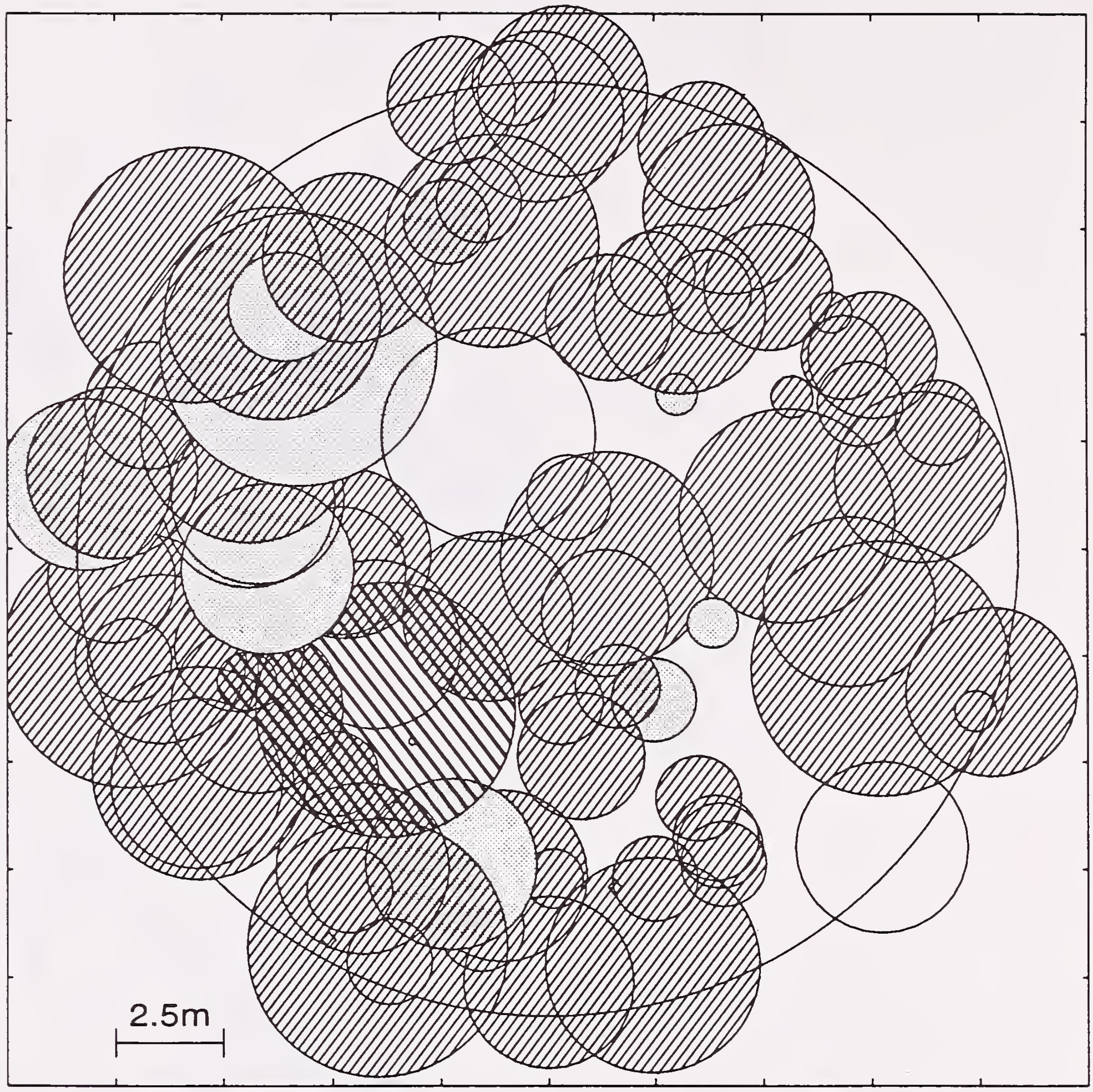


Figure 15—Crown map for stand 29 in the **Betula papyrifera-Populus tremuloides/Viburnum edule** community type, indicating spatial arrangement of stems by species. Fill patterns are: ○ = *Betula papyrifera*; ⊘ = *Populus tremuloides*; ◌ = *Picea glauca*, ◇ = seedling; and ⦸ = *Populus balsamifera*.

Other studies—This community type is related to the **Picea glauca/Viburnum edule/Equisetum arvense/Hylocomium splendens** community type described by Foote (1983). Her type, described from two stands, is characterized by a closed canopy of *P. glauca* that may have developed from *Populus tremuloides* and *B. papyrifera* stands. The undergrowth contains *Viburnum edule, E. arvense*, and *H. splendens*. Her stands are between 150 and 200 years old, which suggests a possible successional sequence. The **BEPA-POTR/VIED** community type as described here represents a new level V type in the Closed Paper Birch-Quaking Aspen Forest (I.B.1.f.) of Viereck and others (1992).

Betula papyrifera-Populus tremuloides/Alnus crispa Community Type (BEPA-POTR/ALCR)

Distribution—The **BEPA-POTR/ALCR** is a major community type sampled throughout the study area (fig. 16) between 240 and 580 meters in elevation (mean = 360 m). It occurs on a variety of aspects but is most common on slopes with southeastern or southwestern exposure. The LES ranges from 50° to 63° (mean = 57°), similar to **POTR/SHCA** and **BEPA-POTR/VIED**. Common sites include middle and upper slopes with gentle to very steep gradients (mean = 21 percent) and straight configurations. Adjacent communities often are dominated by *Picea glauca* and *P. mariana*.

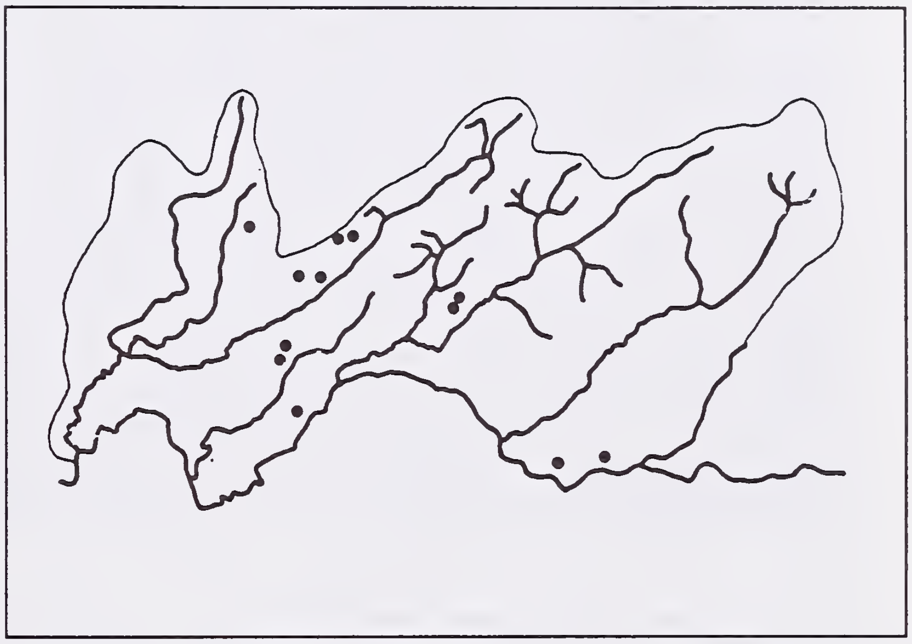


Figure 16—Known locations of the **Betula papyrifera-Populus tremuloides/Alnus crispa** community type in interior Alaska.

BEPA-POTR/ALCR occurs on a wide variety of soils. Thick soils (depth to bedrock exceeding 1.0 meter), are classified as Alfic Cryochrepts and are similar to those supporting **BEPA-POTR/VIED**. Most other soils are less developed and shallower and are classified as either Typic or Lithic Cryochrepts. Bedrock is within 0.8 meter in Typic Cryochrepts and within 0.5 meter in Lithic Cryochrepts. Surface organic accumulations within the community type are between 5 and 10 centimeters thick.

Vegetation composition and structure—**BEPA-POTR/ALCR** has the greatest diversity in species composition of the five community types described in this study. Individual communities, however, are often simplistic in composition, with most of the cover consisting of a few species. The upper continuous canopy is usually dominated by *B. papyrifera* (fig. 17). Grouped in this community type, however, are additional stands in which *Populus tremuloides* dominates the overstory because of uniformity in undergrowth composition. Most communities contain *P. tremuloides* in the upper or B-stratum and sometimes the lower strata. Canopies range from 13 to 23 meters in

Figure 17—**Betula papyrifera-Populus tremuloides/Alnus crispa** community type near the Parks Highway in the Bonanza Creek Experimental Forest west of Fairbanks, Alaska (elevation 381 meters, aspect 200°). Both *Betula papyrifera* and *Populus tremuloides* occur in this stand; *Picea glauca* occurs as small salings in the understory. Clumps of *Alnus crispa* form a broken shrub layer overtopping the grass *Calamagrostis canadensis*.

height when dominated by *B. papyrifera* and 14 to 19 meters when dominated by *P. tremuloides. Picea glauca* occurs in dominant, codominant, or intermediate canopy positions within the B-stratum, and a lower C-stratum, or as an individual emergent extending several meters above the hardwood canopy. *Picea mariana* may occur as individual stems or layered clumps. Density of living trees at least 1.37 meters tall ranges from 960 to 4,100 stems per hectare (mean ± s.e. = 2,195 ± 313).

Frequency distribution of all stems by diameter class differs by species (fig. 18). Total number of living stems ranges from 1,150 to over 10,200 per hectare (mean = 3,809 ± 780). *Betula papyrifera* occurs with a bell-shaped distribution. Most *B. papyrifera* stems occur in the 5- to 15-centimeter diameter class. *Populus tremuloides* occurs with a bimodal distribution; 760 suckers or small stems per hectare are less than 1.37 meters tall, and about 380 stems per hectare are between 10 and 15 centimeters in diameter. *Picea glauca* occurs most frequently as seedlings and *P. mariana* as layerings; their distribution is heavily skewed to the right in a reverse J-curve. Mortality is restricted to the smaller diameter classes of *B. papyrifera* and *Populus tremuloides.*

Basal area per hectare in square meters of living trees at least 1.37 meters tall (mean = 22.51 ± 1.55) and quadratic mean diameter in centimeters (mean = 12.29 ± 0.78) are similar to that in the **POTR/SHCA** and **BEPA-POTR/VIED** community types. *Betula papyrifera* accounts for 62 percent of the basal area and *P. tremuloides* accounts for 32 percent.

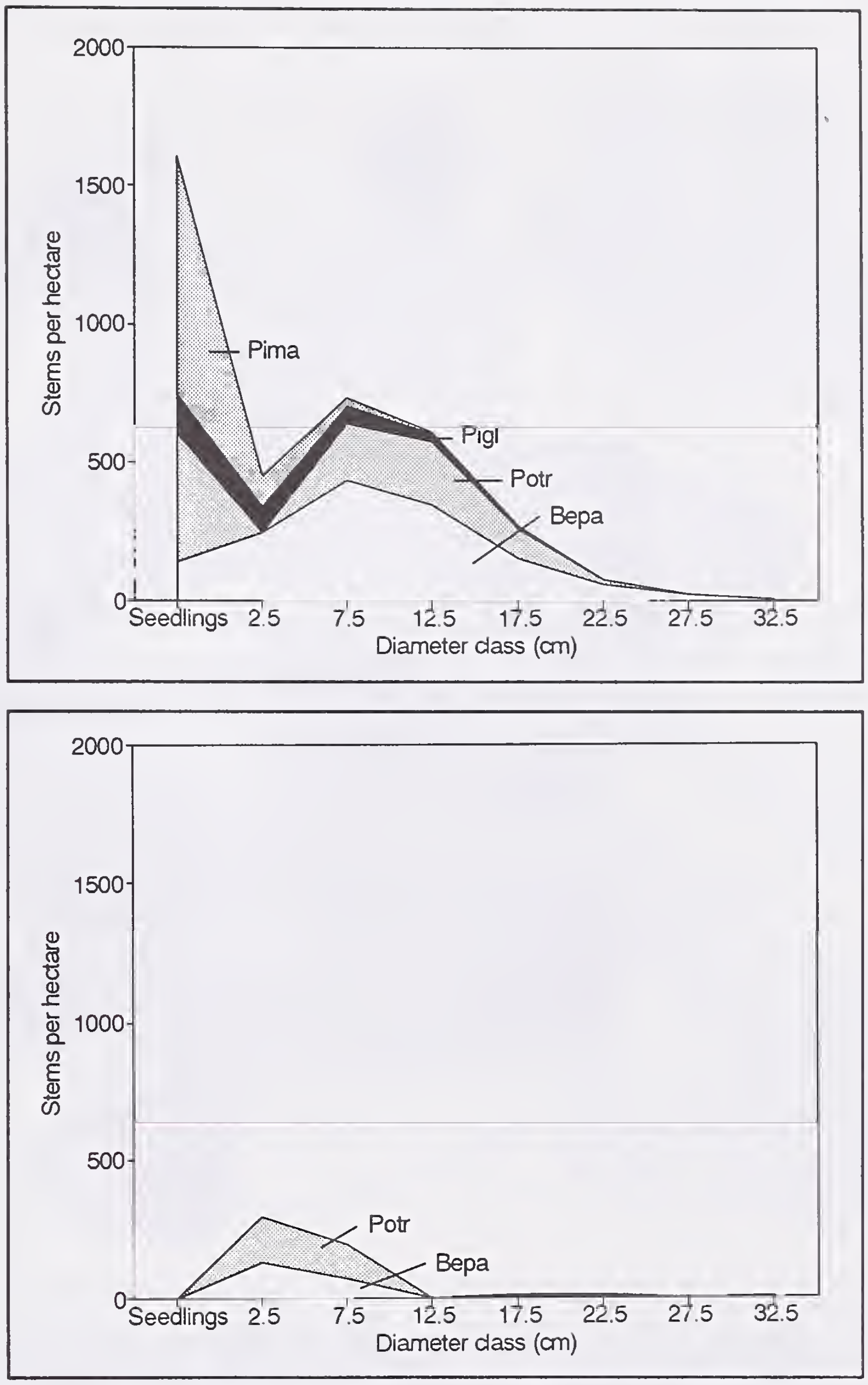


Figure 18—Frequency distribution of living (above) and dead (below) stems by breast-height diameter class and species in the **Betula papyrifera-Populus tremuloides/Alnus crispa** community type.

Total age was determined for 30 *Picea glauca*, 3 *P. mariana*, 30 *B. papyrifera*, and 13 *Populus tremuloides*. The chronosequence of sampled stands in the **BEPA-POTR/ALCR** community type includes a relatively narrow range extending from 59 to 71 total years of age, with one stand containing *B. papyrifera* of 137 to 141 years in age.

Stem maps portray the variability in spatial arrangement and crown structure of stems within **BEPA-POTR/ALCR**. Stand 2 contained 4,267 stems per hectare and 3,573 trees per hectare and was dominated by *P. tremuloides* with crowns ranging from 0.4 to 6.8 meters in diameter (fig. 19). Trees were clustered in dense clumps. Frequency

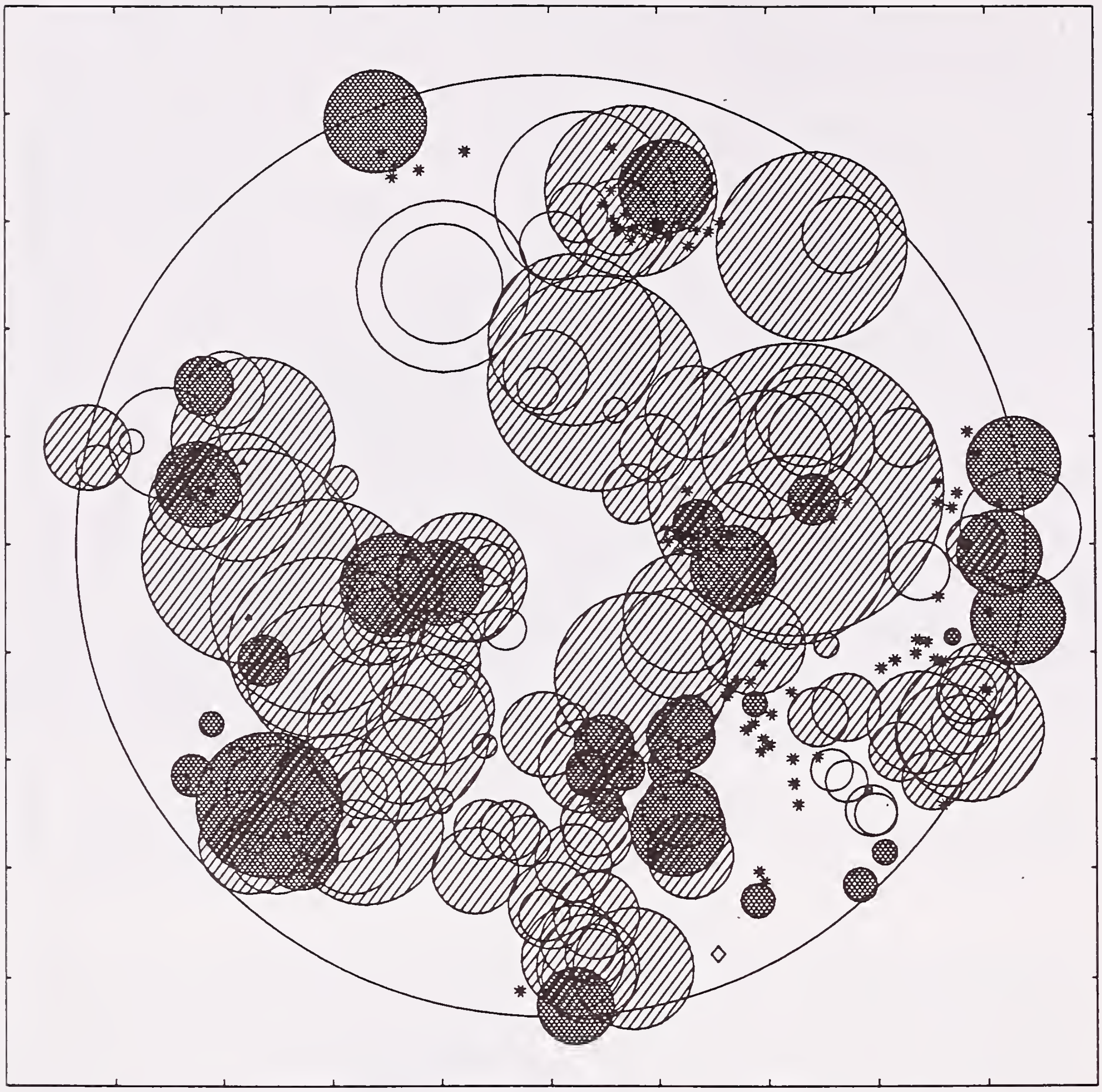


Figure 19—Crown map for stand 2 in the **Betula papyrifera-Populus tremuloides/Alnus crispa** community type, indicating spatial arrangement of stems by species. Fill patterns are: ○ = *Betula papyrifera*; ⊘ = *Populus tremuloides*, ▲ = sucker; ○ = *Picea glauca*, ◇ = seedling; ⊗ = *Picea mariana*, and ✳ = seedling.

distribution of 83 *P. tremuloides* crown diameters was skewed to the right ($g' = 1.17$, $p < 0.01$), with mean and median diameters of about 2.0 meters and crowns of 1.4 meters in diameter occurring most frequently. *Populus tremuloides* stems less than 1.37 meters tall were notably absent. *Picea mariana* was clustered, with many stems being less than 1.37 meters as a result of layering. *Picea glauca* occurred only as well-established seedlings.

Stand 4 contained 2,747 living stems per hectare and 2,400 trees per hectare taller than 1.37 meters (fig. 20). Two-thirds of these were *Populus tremuloides* distributed unequally within the stand. Fifty-nine *P. tremuloides* crowns ranged from 0.2 to 4.0 meters in diameter in a bell-shaped distribution ($g' = 0.30$, $p < 0.01$) with a mean diameter of 2.0 meters. Scattered *B. papyrifera* (n = 35) within this stand had canopies ranging from 1.0 to 6.0 meters in diameter (mean = 2.6 meters). Frequency distribution of these crown diameters was positively skewed ($g' = 0.94$, $p = 0.01$).

Figure 20—Crown map for stand 4 in the **Betula papyrifera-Populus tremuloides/Alnus crispa** community type, indicating spatial arrangement of stems by species. Fill patterns are: ○ = *Betula papyrifera*; ⊘ = *Populus tremuloides*, ▲ = sucker; and ○ = *Picea glauca*.

A final example of spatial arrangement is stand 38, dominated by *B. papyrifera* (fig. 21). This stand contained 2,480 living stems per hectare and over 1,800 trees per hectare more than 1.37 meters tall. *Betula papyrifera* crowns ranged from 0.2 to 6.2 meters in diameter (mean = 2.0 m). Frequency of 60 *B. papyrifera* crown diameters followed a bell-shaped curve ($g' = -0.25$, $p < 0.01$). *Picea glauca* stems were clustered in the upper portion of the sample plot. Crowns ranged from 0.2 to 2.0 meters in diameter (mean = 0.9 m).

All three examples of stem mapping portray a common feature of stem and crown clustering, which leaves canopy gaps above 25 to 50 percent of the forest floor. Regeneration, when present, was not restricted to these canopy gaps. Although field procedures did not specifically address gap characteristics, observations indicated that much of the apparent hole or gap in forest overstory was filled by tall shrubs in a lower stratum.

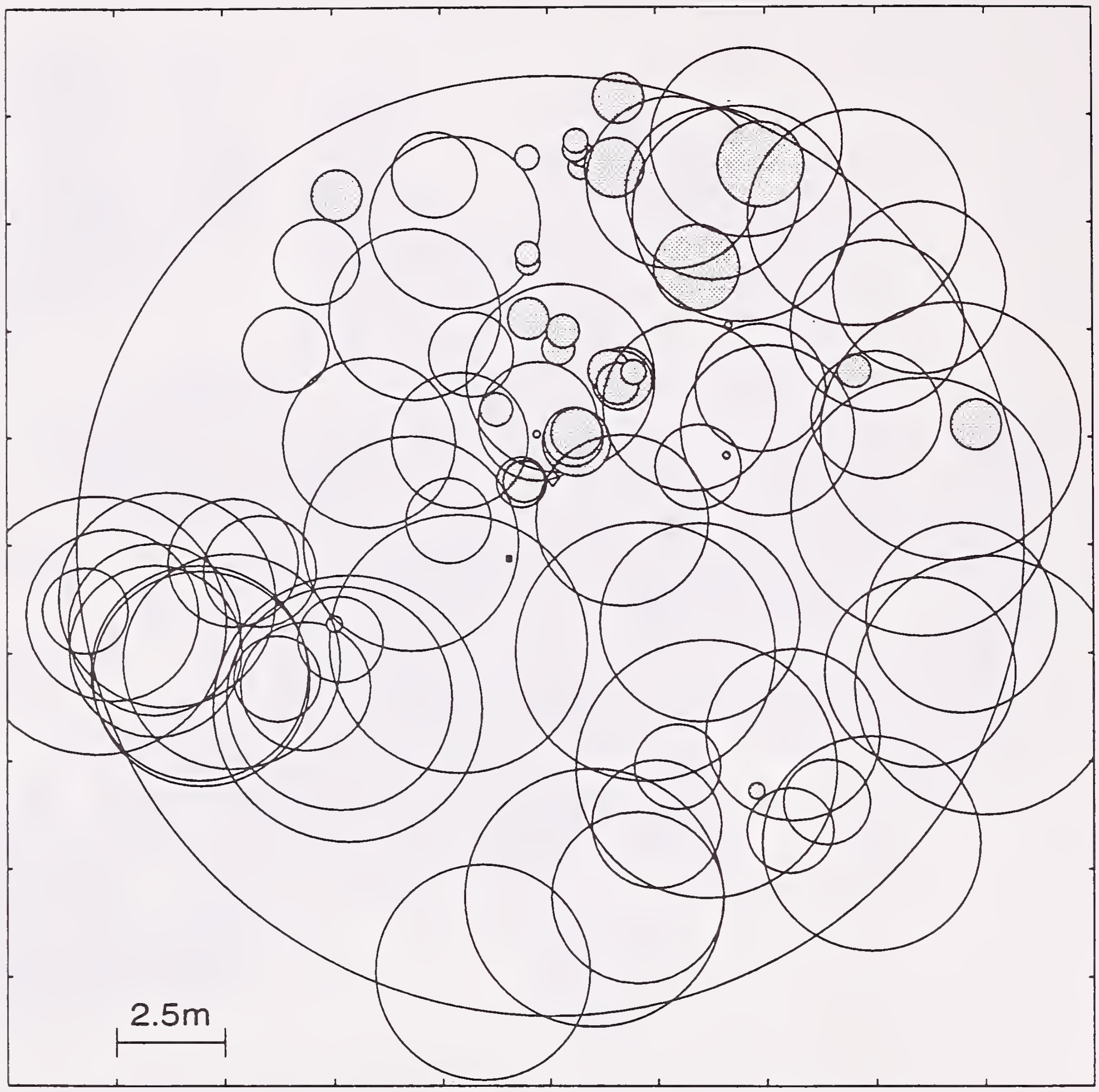


Figure 21—Crown map for stand 38 in the **Betula papyrifera-Populus tremuloides/Alnus crispa** community type, indicating spatial arrangement of stems by species. Fill patterns are: ○ = *Betula papyrifera*, ▪ = seedling; ○ = *Picea glauca*, and ◇ = seedling.

Alnus crispa is present as a distinctive, usually dense, tall shrub stratum. Other shrubs that may occur with lesser canopy cover include *Rosa acicularis, Viburnum edule, Linnaea borealis,* and *Vaccinium vitis-idaea*. Numerous forbs and graminoids such as *Cornus canadensis, Epilobium angustifolium* and *Geocaulon lividum* may be present; none accounts for extensive ground cover. When present, cover of *Calamagrostis canadensis* may be abundant and occurs within the same stands as the feathermoss *Hylocomium splendens*. *Hylocomium splendens* and the low shrub *V. vitis-idaea* often are found growing on decaying downed logs in raised linear patches.

Other studies—Foote (1983) briefly describes two communities belonging to a **Betula papyrifera/Alnus crispa/Calamagrostis canadensis** community type that may be related to this **BEPA-POTR/ALCR** community type. Her stands were determined to be 50 and 130 years and apparently lack the diversity in species represented by this community type. The **BEPA-POTR/ALCR**, as described here, represents a new level V type in the Closed Paper Birch-Quaking Aspen Forest (I.B.1.f.) of Viereck and others (1992).

Picea glauca-Betula papyrifera/Hylocomium splendens Community Type (PIGL-BEPA/HYSP)

Distribution—**PIGL-BEPA/HYSP** is a major community type sampled throughout the study area on eastern and southeastern slopes (fig. 22). It occurs most frequently on gentle to moderately steep middle and lower slopes with straight configuration and on midslope benches. Elevations range from 150 to 430 meters (mean = 260 m). The LES ranges from 60° to 65° (mean = 63°).

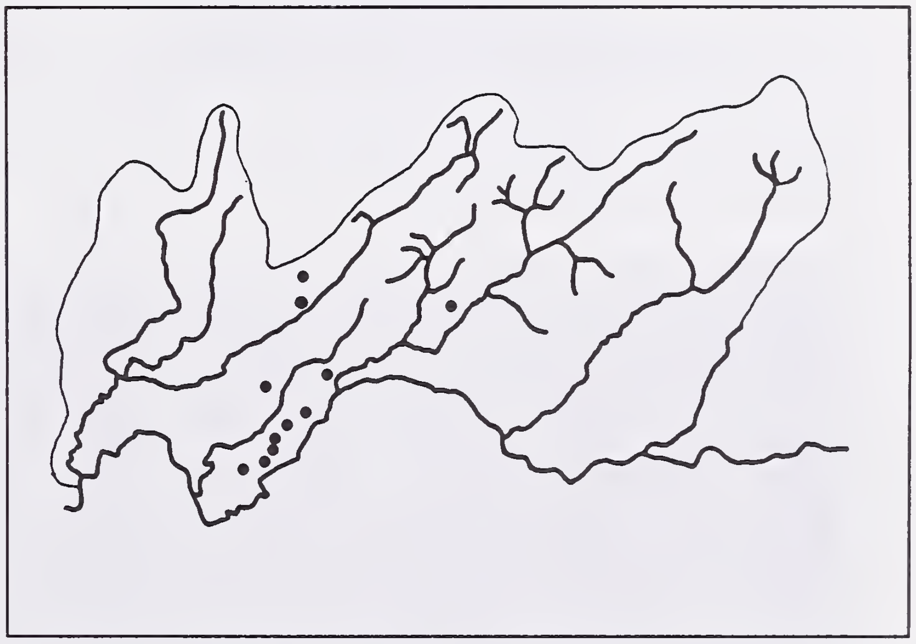


Figure 22—Known locations of the **Picea glauca-Betula papyrifera/ Hylocomium splendens** community type in interior Alaska.

A majority of the sampled communities belonging to **PIGL-BEPA/HYSP** are underlaid with Alfic Cryochrepts that are coarse-silty and have mixed mineralogy. These soils have thin layers of accumulated silicate clays within the profile from weathering of the micaceous loess. High-elevation sites may have shallow soils classified as Lithic Cryochrepts, which are more common in the **BEPA-POTR/ALCR** community type. Stands on the toe of slopes that have been influenced by changing drainage patterns occasionally have soils containing permafrost and are classified as Aeric Cryaquepts. Depth of surface organic accumulations is highly variable within this community type and ranges from 5 to 15 cm.

Vegetation composition and structure—The **PIGL-BEPA/HYSP** community type describes stands dominated by a mixture of *P. glauca* and *B. papyrifera* (fig. 23). Within the community type, vertical stratification of canopies is readily apparent. *Picea glauca* occurs as a dominant, codominant, or intermediate in the upper continuous canopy or extends above the continuous canopy as an emergent with heights ranging from 10 to 21 meters. *Betula papyrifera* may occupy similar positions within the canopy and ranges from 14 to 19 meters tall. *Populus tremuloides* occurs less frequently than does *Picea glauca* or *B. papyrifera* and is found in various canopy positions including emergent. Maximum heights of *Populus tremuloides* range from 16 to 22 meters. Both *Picea mariana* and *Populus balsamifera* occur occasionally; *P. mariana* usually is restricted to a lower C-stratum or an undergrowth layer, and *P. balsamifera* usually is restricted to an intermediate position in the B-stratum.

Density of all living trees at least 1.37 meters tall ranges from 1,360 to 4,933 stems per hectare (mean ± s.e.= 2,759 ± 386), similar to the **BEPA-POTR/VIED** community type. Compared to other community types described in this study, relatively few stems less than 1.37 meters tall are found in this community type. Total number of living stems ranges from 1,573 to 5,813 (mean = 3,084 ± 415), a difference of 325 stems per hectare that are less than 1.37 meters tall.

Figure 23—**Picea glauca-Betula papyrifera/Hylocomium splendens** community type east of Nenana, Alaska (elevation 274 meters, aspect 130°). *Picea glauca* dominates the overstory; *Populus tremuloides* occurs infrequently both in the overstory canopy and as small suckers or saplings. The herbaceous undergrowth is dominated by the feathermosses *Rhytidium rugosum* and *Hylocomium splendens*.

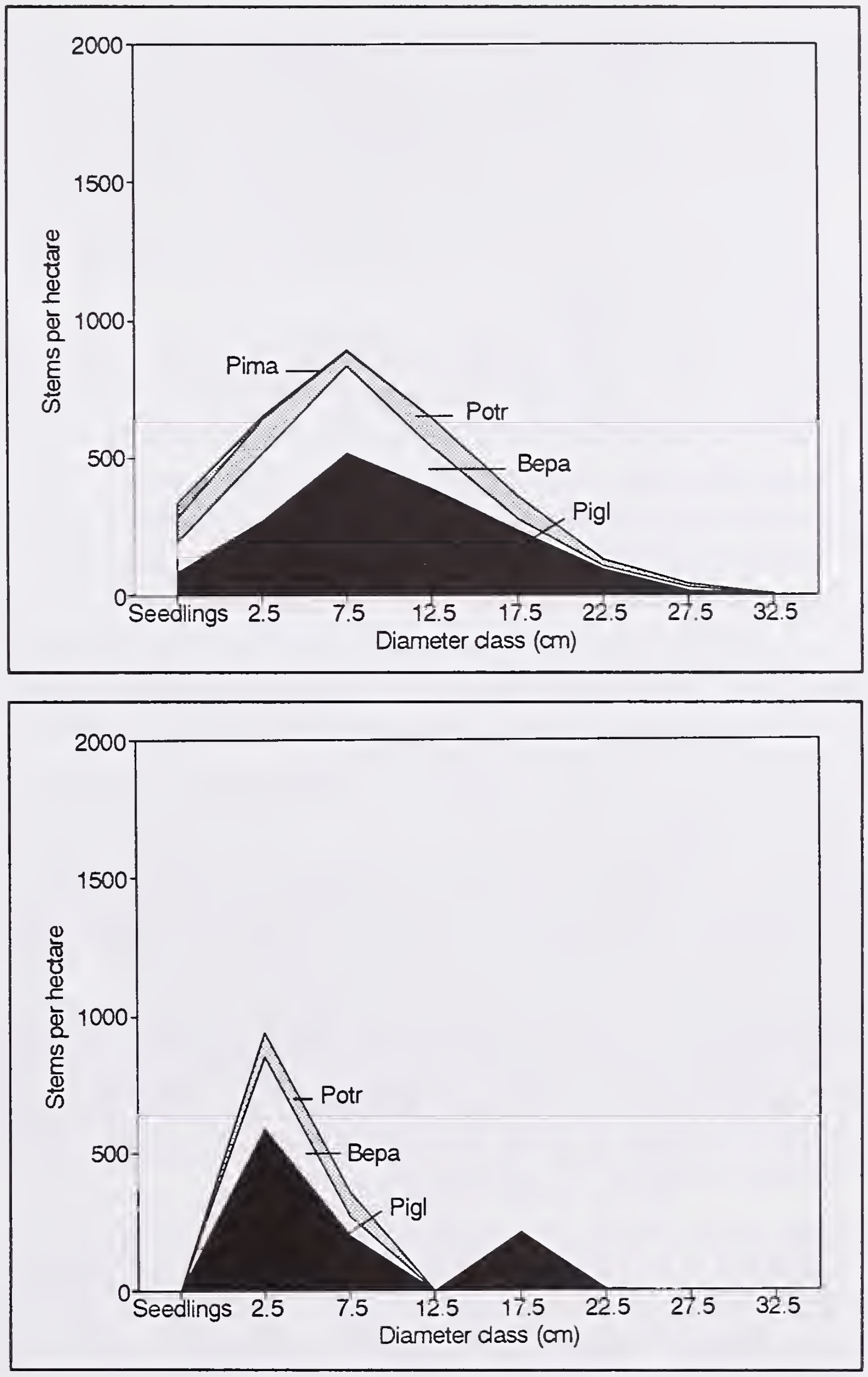


Figure 24—Frequency distribution of living (above) and dead (below) stems by breast height diameter class and species in the **Picea glauca-Betula papyrifera/Hylocomium splendens** community type.

Living *Picea glauca* stems occur in a bell-shaped, skewed frequency distribution across diameter classes, with more than 50 percent of the stems between 5 and 15 centimeters in diameter at breast height (fig. 24). Sixty percent of the *B. papyrifera* stems are less than 10 centimeters in diameter at breast height. Distribution of *Populus tremuloides* stems usually is uniform across diameter classes. Mortality is most frequent in small-diameter *Picea glauca* and *B. papyrifera.*

Basal area per hectare ranges from 8.33 to 44.13 square meters (mean = 29.86 ± 2.83). Quadratic mean diameter ranges from 8.3 to 17.73 centimeters (mean = 12.44 ± 0.88). Both these measures of stem size for trees at least 1.37 meters tall indicate diameters found in this community type are similar to those of the **POTR/SHCA**, **BEPA-POTR/VIED**, and **BEPA-POTR/ALCR** community types.

Stem maps are not available for representative stands within this community type.

Cover of shrubs, forbs, and graminoids usually is sparse. Clumps of *Alnus crispa, Rosa acicularis, Viburnum edule, Vaccinium vitis-idaea*, and *Linnaea borealis* occasionally may account for moderate amounts of ground cover. *Mertensia paniculata* is a common forb. *Calamagrostis canadensis* is notably absent. A dense, nearly complete cover of feathermosses is typical; sometimes this moss layer will be mixed with *Equisetum arvense*.

Total age was determined for 33 *P. glauca*, 1 *P. mariana*, 13 *B. papyrifera,* and 7 *Populus tremuloides*. The chronosequence of sampled stands in the **PIGL-BEPA/HYSP** community type extends from 57 to 107 total years of age.

Other studies—This community type has not been described previously. Based on both overstory and undergrowth species composition and stem density, this community type probably is related to the **Picea glauca/feathermoss** vegetation type (Viereck 1975). His broadly defined type includes flood-plain sites, however, which are excluded from consideration in this study. The **PIGL-BEPA/HYSP** community type, as described here, represents a new level V type in the Closed Spruce-Paper Birch-Quaking Aspen Forest (I.C.1.f.) of Viereck and others (1992).

Validation of the Classification

Data from 12 stands, collected independently of this study by other researchers, were used to validate the classification. One stand with *Populus tremuloides* and *Picea glauca* was on a moderately steep southeasterly slope in the southwestern portion of the study area; it contained over 70 percent combined cover of *Shepherdia canadensis, Viburnum edule,* and *Linnaea borealis*, thereby meeting the criteria for belonging to the **POTR/SHCA** community type.

Seven stands were keyed to the **BEPA-POTR/VIED** community type and fell within the typal concept of geographical and environmental distribution and species composition. These stands had upper slope or midslope positions with aspects ranging from southeast to west, elevations ranging from 210 to 335 meters, and a mean canopy cover of 13 percent for *V. edule*.

One stand clearly belonged to the **BEPA-POTR/ALCR** community type based on overstory and undergrowth composition and physiography. One stand keyed to the same community type, but it may represent a variant between **BEPA-POTR/ALCR** and **PIGL-BEPA/HYSP** because it contained slightly more than 5 percent canopy cover in *A. crispa* and over 70 percent cover in *Hylocomium splendens*. Additional site information and compositional data available in the field would clarify placement. Two additional stands, one dominated by *P. glauca* and one by *B. papyrifera*, met the typal concept of the **PIGL-BEPA/HYSP** community type.

Data from these 12 stands collectively substantiate the relative ease with which stands may be classified in their respective community types and substantiate the distribution of these community types beyond the stands used in their construction.

Conclusions

This classification of young, mixed stands was conducted to form a framework for refining concepts of forest community succession on upland sites. Area of consideration was restricted to a relatively narrow portion of the ecological spectrum for upland forests in interior Alaska: warm and dry sites supporting productive mixed hardwood and *P. glauca* stands. The specific objective was to describe the structural characteristics of young mixed hardwood and conifer stands, including composition, horizontal and vertical arrangement, and component size.

Structural characteristics of young mixed stands are described in terms of community types. A community type is an abstract grouping of all similar plant communities. Community types form a classification tool for partitioning overall variability in species composition within the study area into discrete, recognizable, and mappable units of vegetation. Time since stand-replacing disturbance was based on total age of component stems.

Community types are defined by relative abundance of differential species in the undergrowth. Composition of individual stands may be compared through these species and their relative ecological amplitude, with individual species acting as phytometers. Certain key and easily measured physical characteristics of sites, such as slope, aspect, elevation, and perhaps LES, are likely to influence species composition and therefore the classification of community types. Slope, aspect, elevation, and LES do not form a finite set of ecological parameters, however, and plants are likely to react to the interaction of these and other undefined physical characteristics.

Structural characteristics, including species composition within crown strata, density of living and dead stems by diameter class, quadratic mean diameter, basal area, canopy height, crown size, and spatial arrangement of stems were described by community type. These characteristics differ between and within community types (appendix F). In general, **POTR/ARUV** includes stands with many small-diameter *Populus tremuloides* and an undergrowth dominated by low shrubs. These stands occur on relatively warm and dry, steep south-facing aspects. **POTR/SHCA** occurs on more mesic sites, with an overstory dominated by *P. tremuloides* and an undergrowth dominated by various tall shrubs. Trees are larger and density is less than in **POTR/ARUV** for stands of comparable age. The three remaining community types occur on relatively cool, more moist sites and differ in overall composition and structure. In both **BEPA-POTR/VIED** and **BEPA-POTR/ALCR**, *B. papyrifera* often is a major component, sometimes sharing this role with *P. tremuloides*. Undergrowth structure and composition are dominated by tall shrubs. **PIGL-BEPA/HYSP** has structural characteristics derived from dominance of *Picea glauca* in the overstory and an herbaceous undergrowth with well-developed moss layers.

This study is the first to consider the spatial arrangement of stems in young mixed stands in this portion of the boreal forest. Although not expressly quantified, it indicates the variability in spatial arrangement by species and stem sizes. Opportunities are immense for future research to identify patterns in the spatial arrangement of stems in these stands and the underlying causes for spatial patterns.

English Equivalents

When you know:	Multiply by:	To find:
Millimeters	0.0394	Inches
Centimeters	0.394	Inches
Meters	3.281	Feet
Hectares	2.471	Acres
Square Kilometers	0.386	Square miles
Celsius (°C)	1.8 and add 32	Degrees Fahrenheit

Literature Cited

Barney, Richard J. 1971. Wildfires in Alaska—some historical and projected effects and aspects. In: Slaughter, C.W.; Barney, Richard J.; Hansen, G.M., eds. Fire in the northern environment—a symposium; 1971 April 13-14; University of Alaska, College (Fairbanks), AK. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station: 51-59.

Bowling, S.A. 1980. The weather and climate of Alaska. Weatherwise. 33: 197-201.

Bowling, Sue Ann. 1984. The variability of the present climate of interior Alaska. In: McBeath, Jenifer, ed. The potential effects of carbon dioxide-induced climatic changes in Alaska, proceedings of a conference; 1982 April 7-8; Fairbanks, AK. Misc. Publ. 83-1. Fairbanks, AK: University of Alaska-Fairbanks, School of Agriculture and Land Resources Management: 67-75.

Brown, Jerry; Kreig, R.A., eds. 1983. Guidebook to permafrost and related features along the Elliott and Dalton Highways, Fox to Prudhoe Bay, Alaska: Proceedings, 4th international conference on permafrost; 1983 July 18-22; [Location of conference unknown]. Fairbanks, AK: Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys. 230 p.

Daubenmire, R. 1952. Forest vegetation of northern Idaho and adjacent Washington, and its bearing on concepts of vegetation classification. Ecological Monographs. 22: 301-330.

Daubenmire, Rexford. 1968. Plant communities—a textbook of plant synecology. New York: Harper and Row. 300 p.

Daubenmire, Rexford. 1989. The roots of a concept. In: Ferguson, Dennis E.; Morgan, Penelope; Johnson, Frederic D., comps. Land classifications based on vegetation: applications for resource management: Proceeding of a symposium; 1987 November 17-19; Moscow, ID. Gen. Tech. Rep. INT-257. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 3-6.

Dingman, S. Lawrence; Koutz, Fleetwood R. 1974. Relations among vegetation, permafrost and potential insolution in central Alaska. Arctic and Alpine Research. 6: 37-42.

Farr, Wilbur A. 1967. Growth and yield of well-stocked white spruce stands in Alaska. Res. Pap. PNW-53. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 30 p.

Foote, M. Joan. 1983. Classification, description, and dynamics of plant communities after fire in the taiga of interior Alaska. Res. Pap. PNW-307. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 108 p.

Foster, Helen L.; Weber, Florence R.; Forbes, Robert B.; Brabb, Earl E. 1973. Regional geology of Yukon-Tanana uplands, Alaska. Arctic Geology. 19: 388-395.

Furbush, Clarence E.; Schoephorster, Dale B. 1977. Soil survey of Goldstream-Nenana area, Alaska. [Location of publisher unknown]: U.S. Department of Agriculture, Soil Conservation Service. 45 p. In cooperation with: University of Alaska, Institute of Agricultural Sciences.

Gregory, Robert A.; Haack, Paul M. 1965. Growth and yield of well-stocked aspen and birch stands in Alaska. Res. Pap. NOR-2. Juneau, AK: U.S. Department of Agriculture, Forest Service, Northern Forest Experiment Station. 27 p.

Haugen, R.K.; Slaughter, C.W.; Howe, K.E.; Dingman, S.L. 1982. Hydrology and climatology of the Caribou-Poker Creeks Research Watershed, Alaska. Rep. 82-26. Hanover, NH: U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory. 34 p.

Heinselman, Miron L. 1981. Fire intensity and frequency as factors in the distribution and structure of northern ecosystems. In: Fire regimes and ecosystem properties: proceedings of the conference; 1978 December 11-15; Honolulu, HA. Gen. Tech. Rep. WO-25. Washington, DC: U.S. Department of Agriculture, Forest Service: 7-57.

Helm, Judy, ed. 1981. Handbook of North American Indians. Vol. 6: Subarctic. Washington, DC: Smithsonian Institute. 837 p.

Hill, M.O. 1979. TWINSPAN: a FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Ithaca, NY: Cornell University. 90 p.

Hill, M.O.; Bunce, R.G.H.; Shaw, M.W. 1975. Indicator species analysis, a divisive polythetic method of classification, and its application to a survey of native pine woods in Scotland. Journal of Ecology. 63: 597-613.

Hultén, Eric. 1968. Flora of Alaska and neighboring territories: a manual of the vascular plants. Stanford, CA: Stanford University Press. 1008 p.

Lutz, Harold J. 1956. Ecological effects of forest fires in the interior of Alaska. Tech. Bull. 1133. Washington, DC: U.S. Department of Agriculture, Forest Service. 121 p.

Mueller-Dombois, D.; Ellenberg, H. 1974. Aims and methods of vegetation ecology. New York: John Wiley and Sons. 547 p.

Oliver, Chadwick D. 1980. Even-aged development of mixed-species stands. Journal of Forestry. 78: 201-203.

Oliver, Chadwick D.; Larson, Bruce C. 1990. Forest stand dynamics. New York: McGraw-Hill. 467 p.

Oswald, E.T.; Brown, B.N. 1986. Forest communities in Lake Laberge ecoregion. Inf. Rep. BC-X-282. Victoria, BC: Canadian Forestry Service, Pacific Forestry Centre. 97 p.

Pfister, Robert D.; Arno, Stephen F. 1980. Classifying forest habitat types based on potential climax vegetation. Forest Science. 26: 52-70.

Puri, Subhash C.; Mullen, Kenneth. 1980. Applied statistics for food and agricultural scientists. Boston, MA: G.K. Hall Medical Publishers. 311 p.

Rieger, Samuel; Dement, James A.; Sanders, Dupree. 1963. Soil survey of Fairbanks area, Alaska. Series 1959, no. 25. [Location of publisher unknown]: U.S. Department of Agriculture, Soil Conservation Service. 41 p. In cooperation with: Alaska Agriculture Experiment Station.

Sampson, George R.; Gasbarro, Anthony F.; Ruppert, Forrest A. [and others]. 1983. Forestry in Alaska. In: Alaska's agriculture and forestry. Alaska Rural Development Council Publ. 3. Fairbanks, AK: Cooperative Extension Service, University of Alaska; U.S. Department of Agriculture: 177-199.

Schoephorster, Dale B. 1973. Soil survey of Salcha-Big Delta area, Alaska. [Location of publisher unknown]: U.S. Department of Agriculture, Soil Conservation Service. 51 p. In cooperation with: University of Alaska, Institute of Agricultural Sciences. 51 p.

Schofield, W.B. 1969. Some common mosses of British Columbia. Handbk. 28. Victoria, BC: British Columbia Provincial Museum. 262 p.

Slaughter, C.W.; Viereck, L.A. 1986. Climatic characteristics of the taiga in interior Alaska. In: Van Cleve, K.; Chapin, F.S., III; Flanagan, P.W. [and others], eds. Forest ecosystems in the Alaska taiga: a synthesis of structure and function. New York: Springer-Verlag: 9-21.

Stanek, Walter; Orloci, Laszlo. 1987. Some silvicultural ecosystems in the Yukon. Inf. Rep. BC-X-293. Victoria, BC: Canadian Forestry Service, Pacific Forestry Centre. 56 p.

Van Cleve, K., Chapin, F.S., III; Dyrness, C.T.; Viereck, L.A. 1991. Element cycling in taiga forests: state-factor control. BioScience. 41: 78-88.

Van Cleve, Keith; Viereck. Leslie A. 1981. Forest succession in relation to nutrient cycling in the boreal forest of Alaska. In: West, Darrell, C.; Shugart, Herman H.; Botkin, Daniel B., eds. Forest succession. New York: Springer-Verlag: 185-211.

Viereck, L.A., Dyrness, C.T.; Batten, A.R.; Wenzlick, K.J. 1992. The Alaska vegetation classification. Gen. Tech. Rep. PNW-GTR-286. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 278 p.

Viereck, Leslie A. 1975. Forest ecology of the Alaska taiga. In: Proceedings of the circumpolar conference on northern ecology; 1975 September 15-18; Ottawa. [Location of publisher unknown]: National Research Council of Canada: I-1 - I-22.

Viereck, Leslie A.; Dyrness, C.T.; Van Cleve, Keith; Foote, M. Joan. 1983. Vegetation, soils, and forest productivity in selected forest types in interior Alaska. Canadian Journal of Forest Research. 13: 703-720.

Viereck, Leslie A.; Schandelmeier, Linda A. 1980. Effects of fire in Alaska and adjacent Canada—a literature review. BLM-Alaska Tech. Rep. 6. Anchorage, AK: U.S. Department of the Interior, Bureau of Land Management. 124 p.

Vitt, Dale H.; Marsh, Janet E.; Bovey, Robin B. 1988. Mosses lichens and ferns of northwest North America. Edmonton, AB: Lone Pine Publishing. 296 p.

Weatherhead, Donald J.; Chapman, Roger C.; Bassman, John H. 1985. Properties of the quadratic mean diameter in balanced diameter distributions. Canadian Journal of Forest Research. 15: 474-476.

Yarie, John. 1981. Forest fire cycles and life tables: a case study from interior Alaska. Canadian Journal of Forest Research. 11: 554-562.

Yarie, John. 1983. Forest community classification of the Porcupine River drainage, interior Alaska, and its application to forest management. Gen. Tech. Rep. PNW-154. Portland, OR: Pacific Northwest Forest and Range Experiment Station. 68 p.

Appendix E: Constancy and Average Cover of Important Plants by Community Type[1,2]

Species	POTR/ ARUV	POTR/ SHCA	BEPA-POTR/ VIED	BEPA-POTR/ ALCR	PIGL-BEPA/ HYSP
Trees:					
Betula papyrifera <5 cm	29(6)	25(T)	50(11)	85(7)	45(11)
Betula papyrifera 5-15 cm	14(10)	13(15)	64(37)	92(32)	55(24)
Betula papyrifera >15 cm	14(20)	-(-)	57(36)	85(36)	73(26)
Picea glauca <5 cm	86(9)	100(8)	86(5)	54(8)	82(8)
Picea glauca 5-15 cm	86(9)	88(28)	93(16)	54(16)	82(30)
Picea glauca >15 cm	43(10)	50(14)	64(14)	31(7)	73(40)
Picea mariana <5 cm	-(-)	13(3)	7(5)	38(13)	27(3)
Picea mariana 5-15 cm	-(-)	13(5)	7(10)	23(2)	9(15)
Picea mariana >15 cm	-(-)	-(-)	-(-)	15(3)	-(-)
Populus balsamifera <5 cm	71(2)	13(T)	7(2)	8(T)	-(-)
Populus balsamifera 5-15 cm	43(7)	25(8)	7(5)	-(-)	9(5)
Populus balsamifera >15 cm	-(-)	13(5)	7(30)	-(-)	-(-)
Populus tremuloides <5 cm	100(23)	100(7)	43(6)	15(3)	18(3)
Populus tremuloides 5-15 cm	100(36)	100(47)	57(41)	62(28)	55(15)
Populus tremuloides >15 cm	57(23)	100(37)	43(33)	46(29)	55(24)
Shrubs:					
Alnus crispa	14(2)	25(18)	57(15)	100(33)	55(7)
Amelanchier alnifolia	29(2)	13(2)	-(-)	-(-)	-(-)
Arctostaphylos uva-ursi	100(51)	-(-)	-(-)	-(-)	-(-)
Juniperus communis	29(20)	-(-)	-(-)	-(-)	-(-)
Ledum palustre	-(-)	13(25)	21(1)	46(4)	27(4)
Linnaea borealis	57(14)	88(21)	71(29)	62(2)	73(2)
Rosa acicularis	86(8)	100(11)	93(10)	77(4)	100(3)
Salix glauca	-(-)	25(8)	-(-)	15(1)	9(15)
Salix scouleriana	29(10)	13(5)	14(8)	15(20)	9(T)
Salix species	-(-)	13(2)	21(4)	8(T)	9(2)
Shepherdia canadensis	100(30)	100(30)	14(1)	-(-)	9(T)
Spiraea beauverdiana	-(-)	-(-)	-(-)	15(13)	-(-)
Vaccinium uliginosum	-(-)	-(-)	-(-)	23(7)	18(1)
Vaccinium vitis-idaea	-(-)	25(42)	36(22)	54(6)	55(13)
Viburnum edule	71(21)	100(18)	100(18)	46(4)	64(1)
Forbs:					
Apocynum androsaemifolium	29(20)	-(-)	-(-)	-(-)	-(-)
Cnidium cnidiifolium	57(1)	25(3)	-(-)	-(-)	-(-)
Cornus canadensis	43(5)	50(8)	64(6)	38(6)	36(1)
Cypripedium guttatum	14(20)	-(-)	-(-)	-(-)	-(-)
Delphinium glaucum	14(T)	-(-)	-(-)	-(-)	-(-)
Epilobium angustifolium	57(2)	100(5)	79(3)	54(1)	27(2)
Equisetum arvense	29(T)	75(1)	86(19)	23(5)	73(31)
Galium boreale	100(7)	88(6)	21(1)	8(2)	18(T)
Geocaulon lividum	71(3)	100(10)	21(1)	46(1)	36(1)
Goodyera repens	-(-)	-(-)	-(-)	-(-)	18(T)
Mertensia paniculata	-(-)	63(1)	43(1)	23(2)	64(1)
Moehringia lateriflora	14(T)	-(-)	7(1)	8(3)	9(T)
Pyrola asarifolia	-(-)	13(T)	14(3)	15(1)	9(T)
Pyrola secunda	29(1)	38(1)	29(2)	31(T)	36(T)
Zygadenus elegans	71(1)	25(1)	7(T)	-(-)	-(-)
Grasses:					
Bromus pumpellianus	86(2)	-(-)	-(-)	-(-)	-(-)
Calamagrostis canadensis	43(1)	63(4)	86(8)	69(23)	18(1)
Festuca altaica	14(T)	-(-)	-(-)	-(-)	-(-)
Mosses and lichens:					
Hylocomium splendens	-(-)	25(13)	57(10)	77(4)	82(46)
Lycopodium annotinum	-(-)	-(-)	-(-)	15(1)	-(-)
Lycopodium complanatum	-(-)	-(-)	7(5)	15(26)	9(50)
Lycopodium species	-(-)	25(1)	36(10)	38(13)	-(-)
Moss species:	-(-)	38(1)	7(15)	8(1)	-(-)
Peltigera aphthosa	-(-)	-(-)	-(-)	15(1)	9(50)
Pleurozium schreberi	-(-)	-(-)	-(-)	8(T)	-(-)
Ptilium crista-castrensis	-(-)	-(-)	-(-)	8(T)	-(-)
Rhytidium rugosum	-(-)	-(-)	-(-)	-(-)	18(89)

[1] Average cover given in parentheses.

[2] T indicates a species was present in a given community type, but that its average cover value was less than 1 percent. A dash indicates complete absence of a species from a community type.

Appendix F: Structural Characteristics of Stands by Community Type

Stand	Age[1]	Canopy height[2]	QMD[3]	Density	Basal area
		Meters	*Cm*	*Trees per ha*	*m^2 per ha*
POTR/ARUV:					
21	58	6.4	3.3	4,293	3.7
12	58	12.3	7.6	4,027	12.6
49	58	8.9	5.5	5,840	14.4
48	65	10.3	6.8	3,280	12.0
11	66	13.1	5.2	3,733	7.9
44	71	13.9	9.8	2,533	19.1
10	87	20.3	11.6	1,200	12.6
POTR/SHCA:					
35	66	15.2	10.9	2,240	20.8
9	72	20.2	14.4	1,253	20.5
36	72	14.2	8.9	3,547	22.2
24	75	18.0	12.0	2,293	26.1
45	78	16.4	10.9	2,960	27.6
14	86	22.1	16.6	2,187	47.2
19	86	19.4	11.5	2,267	23.4
8	93	NA	14.3	1,867	29.9
BEPA-POTR/VIED:					
42	46	11.9	6.8	6,427	23.6
55	53	18.1	11.3	2,533	25.5
20	54	12.3	19.8	5,040	22.7
6	56	17.5	9.2	4,187	26.4
5	63	17.5	8.3	2,987	16.0
29	63	25.0	16.7	2,187	47.9
37	64	19.2	16.9	853	19.1
50	66	11.9	8.5	2,907	16.4
32	70	15.0	10.7	3,147	28.4
39	72	23.6	13.2	2,320	31.5
18	74	18.5	13.7	2,213	32.4
16	75	18.8	15.0	1,333	23.7
13	82	18.4	16.0	1,467	29.5
30	136	21.5	19.8	773	23.8
BEPA-POTR/ALCR:					
3	59	15.0	14.1	1,123	17.5
2	61	17.3	10.2	3,573	29.4
4	62	18.3	12.9	2,400	31.2
27	62	16.2	10.6	2,907	25.7
28	63	14.5	8.4	4,107	22.7
43	63	16.1	9.2	3,440	23.3
38	63	16.4	13.5	1,813	26.0
51	65	12.8	12.6	1,520	19.0
47	65	14.5	10.8	1,253	11.5
52	65	17.2	16.7	960	20.8
41	71	15.2	14.5	987	16.2
33	71	17.9	9.3	3,227	21.7
31	141	23.0	16.9	1,227	27.5
PIGL-BEPA/HYSP:					
1	58	13.5	10.4	2,960	25.3
7	63	17.5	8.2	1,573	8.3
53	64	15.0	8.5	4,933	28.2
40	64	17.5	12.4	2,667	32.3
34	71	17.7	10.1	4,480	35.6
46	73	19.3	10.2	4,000	32.4
22	73	20.0	15.5	1,600	30.1
17	75	17.3	17.7	1,787	44.1
15	75	20.7	16.2	1,680	34.4
23	76	16.5	11.9	3,307	36.6
54	107	18.5	14.0	1,360	21.0

NA = Not available

[1] Age of the oldest sample tree

[2] Mean maximum height of dominant and codominant trees

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A total of 53 upland mixed communities were sampled and classified into five community types: **Populus tremuloides/Arctostaphylos uva-ursi**, **Populus tremuloides/ Shepherdia canadensis**, **Betula papyrifera-Populus tremuloides/Viburnum edule**, **Betula papyrifera-Populus tremuloides/Alnus crispa** and **Picea glauca-Betula papyrifera/Hylocomium splendens**. Community types were described by distribution and physical environment, vegetation composition, structural features, and relation to previously described vegetation units.

Keywords: Vegetation classification, community types, mixed stands, interior Alaska.

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